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THE EVOLUTION OF SYMBOLS IN THE DEVELOPMENT OF CONSCIOUSNESS *

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NEW YORK

To attempt to approach the problem of the nature of the mind, and especially that part of it that is known as consciousness, may well seem to be "rushing in where angels fear to tread," but many have made and are making the attempt from many points of view, varying in countless gradations up or down the scale from deism to neural or even glandular physiology. The older academic psychology stressed consciousness until it became impossible to connect it with any bodily or organic function. Behaviorism eliminated this troublesome concept by the simple process of denying its existence, and, freed thus from this incubus, has made many valuable contributions to animal and human psychology. Behavioristic psychology is definitely in line with the rest of body physiology, especially neurophysiology, but still it leaves just that gap which cannot be filled with denial. Psychoanalysis clarified our understanding greatly by conceiving of the psyche as consisting of a mosaic of interlocking reaction of which consciousness is but one. Such a concept one can deal with from almost any point of view one wishes except perhaps a formal religious one. With such a concept even a neuroanatomist may turn his hand to the problem in the hope of adding a little clarity to the general haze by application of his methods of solution. What will result may be some thoughts and then again may be but formulations.

In an earlier paper [1] I sought to enumerate certain facts which show the close connection between the physiology of the central nervous system and the mental life in the hope of attaining thereby an approach to the problem of consciousness—the highest and most recently acquired level. Psychology may be looked on as that part of physiology which deals with the reaction of the whole organism to its environment—exophysiology—just as the other physiology, which treats of the reaction of individual organs to each other and to themselves may be considered endophysiology. The nervous system is the organ of body control,

* Submitted for publication, March 11, 1929.

* President's Address read at a Meeting of the New York Neurological Society, March 5, 1929.

1. Casamajor, L.: Some Nervous System Factors in the Make-Up of Consciousness, Am. J. Psychiat. **8**:457 (Nov.) 1928.

and while it is of extreme importance in endophysiology, its main function is exophysiologic. It is the organ of the mind in every one of its functions from the simple reflex act to consciousness, together with the conscious elaborations of thought and reason. As one reviews the physiology of the central nervous system, progressing cephalad from the spinal cord, one observes a progressive elaboration of function complexity, at each arbitrary level of which the exophysiologic responses become more complex, more directive and more efficient. It is not unlikely that this tracing upward recapitulates rather roughly the phylogenetic development of this organ of defense, the lowest function of which is the sensorimotor reflex and the highest, consciousness.

With the development of the brain with its greater efficiency of reflex reaction capacity, organs of control became necessary "to free the individual from the tyranny of reflex action," [2] and these organs of control developed from the dorsal part of the neural tube—the tectum. The cerebellum from the hind brain tectum exerts directive control on muscular reactions more in the interest of coordination than of purpose. With the formation of the colliculi from the midbrain tectum, each pair of which represent distributing centers for impulses derived from special senses—hearing and sight—there appears a directing mechanism for the utilization of sensory impressions by means of reactions more or less purposeful in character. Were one now to ascribe the quality of memory to these directive organs their physiology might well form the basis for a reaction capacity well above the simple reflex level and closer to the psychologic in their capacity of responding with directive purposeful movements, approximating if not attaining the function of volitional control. Work on myelinization in relation to behavior [3] has adduced evidence that such memory capacity does exist in the colliculi. Each pair of colliculi appears to have the capacity of handling its own sensation to meet those reaction needs of which the animal is made aware, by means of each sensation, by reaction groups more efficient than reflex action, but there their ability seems to stop. Anatomically, they are isolated from each other and especially from the centers of other important sensory impressions, smell, taste and general bodily sensations, especially those discriminative "gnostic" sensations of position and movement and of tactile discrimination. They have not the structure nor anatomic position to be able to connect themselves with the other centers and so ally their sensory functions with those other important ones, which alliance is essential for the completion of concepts of the world outside. It is this isolation

2. Brown, W.: Hunter, Gaskell and the Evolution of the Nervous System, Lancet **1**:641, 1920.

3. Tilney, F., and Casamajor, L.: Myelinogeny as Applied to the Study of Behavior, Arch. Neurol. & Psychiat. **12**:1 (July) 1924.

which has kept their functional capacity probably considerably below the level of that which one can call conscious.

In the development of the forebrain tectum—the cerebral hemispheres—the anatomic limitations which obtain in the colliculi do not exist. The cerebral hemispheres represent an organ of sensory reception, interpretation, and memory in which centers for all the special senses exist in close associational connections with each other, with those for general bodily sensations—especially the gnostic ones—and with those for regulation, if not the initiation, of voluntary motion. Such an anatomic structure permits the greatest efficiency of interrelation of reception and memory functions, the completion of concepts based on reception and memory, a high grade of efficiency in reacting to these concepts with a purposefulness that may be called volition and a sensory clarity in the interpretation of concepts which is understanding.

To attempt to define words used by psychology in terms of neurophysiology is an exercise ever fraught with danger; yet one must observe that psychology's own definitions are often far from satisfactory. Not infrequently a mere synonym passes for a definition. If definition means the exposition of the meaning of a word in terms of the function or the idea it tries to express, then the neurologist cannot be at fault in offering definitions of psychologic nomenclature in terms of neurophysiology.

Mental life has as its function the adaptation of the person to the life he has to live, and this he does by means of reactive responses, motor, emotional and intellectual. These reactions are more or less efficient, depending on many factors in the life of the animal, his tissues, his experience and his education. One judges a person's intelligence mainly by his reactions to certain stimuli called tests, and the sum total of all his reactions gives a concept of his intelligence. Intelligence then is but a term to express the relative efficiency of the reactive capacity of the man.

The cerebral cortex, then, is an organ primarily of sensory function, wherein are brought together in close associational interrelationship all of the senses which give the most accurate concepts of objects in the environment. In order to appreciate the nature of that environment one needs the evidence of those senses together with the emotional content which experience or instinct has given to the concept. By means of these senses one knows objects and hence, with Kappers, one may describe them all as gnostic senses. It is by means of those senses carried by nerve fibers which terminate centrally in the cerebral cortex that man knows things that are outside himself, and how well he knows them depends on how many sensory images may be evoked to complete the concept and the clearness with which these sensory images exist in the psyche. The more sensory images, the more memories, emotional and intellectual, there are, the better does one know a given object—

the more accurate is cognition. When one senses well himself and his environment, when he feels adequately toward it and reacts to it intelligently, he is said to be conscious. Consciousness is a term to describe states of relative cognitive clarity. The unconscious consists of cognitions which are unclear and incomplete. Assuredly the cerebral cortex has anatomic capacities for such functions as I am discussing.

With all of sensory impulses and memories that go to make up cognition brought together into one organ; with ample opportunity for expansion for each and all, and with ample opportunity for the establishment of associational pathways from each to all we see a plausible basis for a psyche composed of mental states the common characteristic of which may be the cognitive clearness of consciousness. With so much value resident in different sensory experience, there was needed only a coinage to make that value interchangeable and to release it in terms of psychic work. The coinage of the mind is the "Symbol."[1]

A symbol is something which for some reason has come to mean something else. The simplest of symbols are sensory perception symbols; the most complicated are memory and ideational symbols that enter into thought. Reactions, valuable to the life and welfare of the individual, may result from various stimuli, pleasant or dangerous, purely on the basis of instinct. These reactions, usually wholly in the interest of the instincts of self-preservation and preservation of the species, are common to the species, occur untaught and are more or less stereotyped in their expression. They occur so naturally that little if anything of consciousness is necessary for their production. They occur in forms so low that the nervous system must be incapable of supporting the structure of consciousness and hence cognitive clarity anatomically is impossible. Not only does consciousness not operate in these reactions but when, perchance, it does enter into them, usually it impairs their efficiency. When, for any reason, however, they must be curbed, it requires a great deal of conscious effort to attain the result.

Such reactive responses all animals possess in common with others of their kind, but each individual is able to acquire others by experience if there is advantage in so doing. Undoubtedly this occurs in the wild state, and one observes it in the habits of game that have been much hunted. Here some learn the new and more efficient reaction much more readily than others and use it to better advantage. Some never learn a new reaction. The more intelligent the animal and the better the development of his forebrain the more rapid and versatile his learnings. Koehler's chimpanzees[4] learned reactions by themselves which none of the infraprimate forms would be capable of learning after the most intense teaching.

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4. Koehler: Intelligenzprüfungen in Menschenaffen, Berlin, 1921.

Such learned reactions as this often differ little from the instinctive ones and hence are easily acquired by the major part of the whole group. In a short time such a reaction is shared by all members of the group in common, as consistently as the instinctive ones, and in practice it is indistinguishable from the older reactions.

Pavlov, in his experiments with conditioned reflexes, has shown that an altogether different kind of learning may take place even in animals that spontaneously show little tendency to alter their instinctive reactions. The conditioned reflex is an individual learned reaction. It belongs to the individual alone; he does not share it with others of his kind, unless they have been similarily trained; and he forgets it if he goes without using it for a period of time. The stimulus of the conditioned reflex becomes, then, a symbol, in that it is something which means something else. The process of conditioning a reflex is the process of symbol formation.

In this process of symbol formation (conditioning the reflex to the stimulus) the emotional content of the situation must first be altered, becoming either more or less pleasant depending on the original meaning of the response wanted. In other words, the stimulus must take on a new affect value and if it originally had an affective tone it must lose it before the new can be acquired. Only when this new affect value has been acquired can the conditioned reflex take place. It is this assumption of a new affect value which characterizes the symbol and gives it those functions that differentiate it from a simple stimulus. If a stimulus originally had an affect value more or less innate and a new acquired feeling tone be added, it is doubtful if the original affect is entirely lost; and thus the symbol becomes complicated in carrying two more or less related, or possibly unrelated, feeling tones. Such a psychologic phenomenon with its increase of meanings must differ considerably from a simple memory—and in that difference it is raised from the simple memory level nearer to that of a complete concept—an idea or a thought. It is likely that when an animal acquires the capacity for developing conditioned reflexes he develops to just the same extent an ability to think, for it is likely that the symbol stands as a bridge between stimulus, memory and ideation.

As has been pointed out, animals acquire conditioned reflexes readily or with difficulty, depending on the development of the cerebrum among other things. The greater the capacity for correlating the sensory characteristics of any given object with a view to sensory and therefore cognitive clarity, the more readily are affect values altered and the more readily are symbols formed. When the cognitive clarity of consciousness characterizes the mental state—as in man and the other anthropoids at least—symbol formation may occur rapidly without the routine of long experience. When means of communication between individuals exist—gesture and speech—the symbol may be communicated

complete with its altered affects, or in other words the second individual may "get the idea" of the new response through his intellectual side and not be obliged to learn it emotionally by long experience. Such a utilization of the symbol approaches close to the realm of ideation, for the communicated symbol becomes a thought in the process.

The psychology and especially the conscious psychology of man depends on the ability to communicate his symbols to others. With a community of symbols and the constant acquisition of new ones knowledge becomes greater, cognitive clarity still more clear. The mental states of all animals capable of developing conditioned reflexes must have at times something of this cognitive clarity just as many of the mental states of man have so little of it—the unconscious. The bulk of all mental processes is unconscious, and consciousness is merely a relative term for cognitive clarity. The animal with the best symbols is the one who utilizes experience most efficiently and appreciates things with greatest clarity. The animal that is capable of the greatest consciousness is the one whose symbols are communicable to his fellows and so interchangeable. The animal that talks is undoubtedly the most conscious of all.

When symbols come to be communicable they become interchangeable with the thing or things for which they stand. The process becomes reversible and not only does the stimulus evoke the response but the response alone has the power of evoking a memory picture of the stimulus both in the mind of the one reacting and also in that of others to whom the facts of the reaction may be known. This fact makes possible, in an animal that can exchange symbols, an intercommunication of emotional tones and reactions, of ideas and of thoughts. This function of utilizing the response to evoke the original stimulus, symbol or idea, is the psychologic basis for gesture—that most primitive method of interchange of symbols and ideas. Gesture and that most highly specialized form of gesture—speech—have made possible the reproduction in the mind of one person mental states which exist in another, and this reproduction can exist in terms of a cognitive clarity far greater than is possible in an animal incapable of these functions. The animal that talks must use his symbol formation ability to clarify his own concepts before he is able to communicate them.

The symbols with which the conscious deals are more or less stereotyped in meaning. They have their meaning by general agreement. This must be, because they are the medium by means of which one mind communicates with another. The symbols of the unconscious, however, are distinctly individual and usually have no meaning to others or even to the conscious part of the same mind. This is well illustrated by the symbols which make up dreams and many of the productions of schizophrenic patients.

The symbols of consciousness that I am considering are of many different sorts. Some of them are as individual and unformed as those utilized by the unconscious. They belong in reality to those mental states between the two. Such conscious symbols have many meanings in that they stand in lieu of many different emotional and intellectual states. The color red stands not only for passion, hatred and anger, but also for love of a desirable sort. Besides this it symbolizes blood and fire and, in one's mind, means just as strongly the port side of a ship, danger ahead and the proper time to stop your automobile. The memory of such a stimulus has much more the status of an idea than of a simple memory, but it is difficult to use in speech because it means too much. The use of such a symbol would make for confusion rather than that cognitive clarity that one seeks to approach in consciousness. It is a useful symbol for carrying an idea when clarity is not essential, but when this clarity is needed symbols which mean fewer things and hence have more directive import are called for.

Beginning with gesture symbols, which make up many of the symbol formulations of the lower forms, one sees a mechanism for the expression of emotional states that meet many of the needs of the individual. More efficient still are the sound symbols that are capable of greater refinement and hence more accuracy in feeling and thought conveyance. Man has gone far beyond other mammals in his use of sound symbols. He has increased the number of sounds he can make with his vocal apparatus by the addition of tongue and lip sounds. Besides this, he has accurately standardized the meaning of many of the sounds in the formation of words. Still more, he has split these words up into arbitrary symbols—letters—so that he may perfect the standardization and add a cognate visual imagery to his sound symbols to make their value greater and to allow appreciation of mental states of others by means of sight as well as by means of hearing.

Thus the advent of language made for greater cognitive clarity in psychic phenomena, for not only did it facilitate the transmission of feeling tones and ideas, but it allowed each one to know more clearly what he himself felt or meant and forced him to formulate it more clearly in order properly to transmit it. The use of language symbols not only increased the intensity of consciousness but raised much more of mental life to the conscious level. This is shown by man's greater memory of the past, his disinclination to live only for the present and his infinitely greater tendency to plan for a future which his broader consciousness permits him to envisage with greater accuracy and clearness.

The acquisition of speech symbols then has resulted in increasing the value of consciousness. Animals whose mental processes are not verbalized undoubtedly possess a good deal of consciousness and are capable of thought and of transmitting their affective states to others by means

of gesture and sound. However, it is likely that such a consciousness is not so clear nor so broad as that of man who possesses in words a symbolism of greater clarity. Words, however, are probably not the symbols in terms of which man thinks. Thought processes seem to be more indefinite than that. How often does one grope around seeking to find words to express one's thoughts, how difficult are they to find at times but how necessary if one is to have a clear concept of what he means? Verbal symbols are not the ones that initiate thought, but they are the ones which raise the thought to a conscious level.

"When man learnt to speak," said Head [5] "and to understand spoken words he acquired the power of registering relations. Action was no longer determined by perception and unformulated emotional response. The use of symbols materially shortened the processes and extended his power of thinking." Speech is not necessary to thinking, but without speech it is difficult for thinking to become conscious. Head has shown that this is true in aphasia, in which thinking processes remain although much impaired by the loss of verbalization, the symbol coinage by means of which they become most conscious.

Varendonck [6] defined thinking as "the decomposition of a memory to adapt the proper elements to a present situation under the influence of affect or will." Such a process does not require speech, but the part that speech plays in it is well expressed by Head.[5]

> Words and other symbols knit together and give permanence to non-verbal processes of thought which would otherwise be fleeting. This is particularly evident in the case of visual images. Should an aphasic possess this kind of memory in a strongly developed form, images may arise spontaneously and play a considerable part in his mental processes. But he cannot evoke them at will or to command; nor can he unite them to a coherent logical sequence without the help of verbal symbols. They are episodic, fleeting and transient; they arise and perish without leaving behind them any permanent or certain addition to thought. Without names we cannot record their relation in time or space, nor their essential likeness or difference.

The mind is one of the functions of nerve tissue and is the most efficient of those reaction formulas by means of which an animal is able to live in a world of both pleasures and dangers. The symbol is the mechanism whereby perceptions, images and memories are released in terms of psychic work. In evolution, mental states tend to become clearer in the higher forms, and this relative clarity of cognition is consciousness. Speech symbols, the most efficient of human mental symbols, comprise the great bulk of consciousness, leaving to the unconscious those other more inarticulate symbols which man probably shares in part with the rest of the mammals.

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5. Head, H.: Aphasia and Kindred Disorders of Speech, New York, The Macmillan Company, 1926, vol. 1, pp. 523 and 525.

6. Varendonck, J.: The Evolution of the Conscious Faculties, New York, The Macmillan Company, 1923, p. 49.

THE SOCIAL SIGNIFICANCE OF MENTAL DISEASE*

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In choosing a subject, I have decided on "The Social Significance of Mental Disease," because I believe that a discussion of mental disease from the point of view of its social significance not only will appeal to a larger audience than almost any other aspect of psychiatry, but will, I feel, be in harmony with Dr. Kober's purposes in founding these lectures, and because the illumination of the social aspects of psychiatry has been perhaps more distinctly American in origin than any other aspect of this medical specialty. In my lecture I will undertake not only to set forth the more outstanding facts bearing on the social importance of mental disease, but to correct, I hope, some serious misapprehensions regarding it; to proceed to the illumination of certain additional problems which are in line with tendencies in medicine and in biology generally that are just now coming to the front, and, finally, to suggest certain interpretations that are not generally considered but that, if true, are of great significance from the point of view of both the biologic and the social sciences.

In order to become properly oriented toward this whole problem, it is necessary for me to deal with certain matters that are capable of being reduced to statistical expressions. When one deals with the statistics of mental disease one must necessarily deal almost exclusively with the statistics of patients in public institutions; these patients are usually designated as insane, epileptic and feebleminded, and there are corresponding institutions for these three classes. These designations have no medical or scientific significance except in the roughest sort of way. They are merely terms for the classification of certain social groups which it has been found expedient to segregate more or less. It is true that many of these institutions are conducted on a broad basis of both concept and practice, and that the mentally ill are admitted to them for treatment irrespective of these cruder considerations; yet the whole matter of the social attitude toward these three groups is shot through with these less scientific but more practical aspects of segregating individuals from the group who are either dangerous to the group or persistently or disagreeably annoying and troublesome.

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* Submitted for publication, April 3, 1929.

* From St. Elizabeth's Hospital.

* The Kober lecture for 1929, delivered at Georgetown University, March 25, 1929.

DISTRIBUTION OF INSANITY

First, one may take a brief survey of the distribution of the so-called insane through the United States, beginning with the year 1880.[1] A glance at a map (fig. 1) which gives the ratio of the total number of insane persons per hundred thousand of the population, in accordance with the census of that year, shows, if one examines the figures for the different states, that the greatest proportion of insane are found in the Northeast and in the West. An examination of the social conditions of the country and the movements of population will make it clear why this should be so.

Fig. 1.—Ratio of total insane per hundred thousand population, according to the census of 1880.

On the map in figure 2, the proportion is shown in accordance with groups of states, and the whole situation is made much clearer. The Atlantic seaboard represents the original area of settlement of the country. It was from this area of original settlement that the population streamed westward. Two things result in an area when a social movement of this sort takes place. The area loses its bravest, most courageous and efficient members, who go forward to seek their fortunes in an unknown land. Those with the greatest initiative and

1. White, William A.: The Geographical Distribution of Insanity in the United States, The National Geographic Magazine **14**:361 (Oct.) 1903.

energy are not those who contribute the largest quota to the statistics of insanity. At the same time, the other aspect of the situation is brought into relief; namely, that the old, the feeble and the sick, and those who are lacking in courage, initiative and energy, are left behind. This includes a number of the either mentally ill or potentially mentally ill, the feebleminded and those otherwise incapacitated. It is natural, therefore, that these regions that have been longest settled and that have been the seat of these changes should show the highest percentage of mental disease.

As shown on the map, the greatest proportion of insanity occurs in the New England and Middle States, of which New Hampshire, Vermont, Massachusetts, Connecticut and New York have one insane person to less than 400 of the population. It is also natural to expect

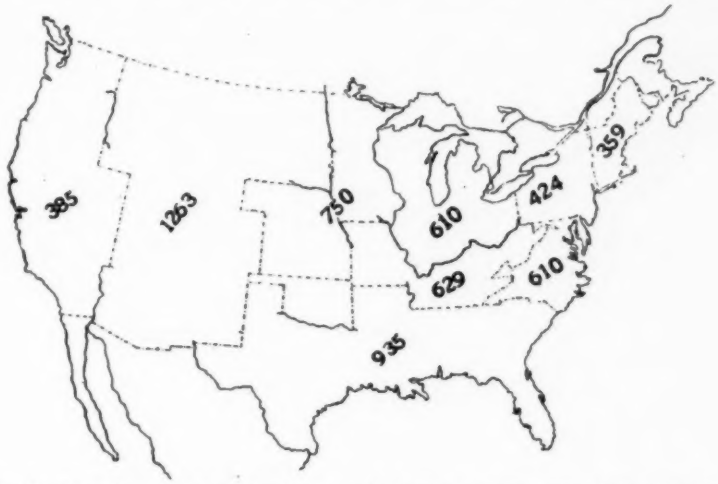

Fig. 2.—Number of the population to each insane person, according to the census of 1880.

that the great regions in the West and the Middle West that were settled by the pioneers from this eastern region should show a much lower percentage of mental disease, which is also the fact. The region of the next highest incidence of mental disease is the Pacific coast. If a line is drawn from the center of greatest prevalence of insanity in any direction, west, south or southwest, a steady decrease is seen until one strikes the Pacific slope. This, like the Atlantic coast, is a port of entry, and had I the time to discuss the relation of immigration to mental disease I could show that this question bears on the high proportion of insane in the states on the Pacific coast. But aside from this, the general thesis that I have already indicated holds true. The frontiersman who takes his family and goes west to enter new territory, to engage in agricultural pursuits and to grow up with

Fig. 3.—Ratio of total insane per hundred thousand of the population, according to the census of 1890.

Fig. 4.—Location of cities having a population of 50,000 or more, according to the census of 1890.

the country is apt to be of hardy stock. The attraction of California, however, and the adjoining states has been of a different character. The gold fever of 1849 attracted a great mass of the unstable elements in the population, who went there with the hope of getting rich quickly with a minimum of effort; it is largely due to the attraction of this type that one finds the figures here so large.

As a further illustration of this general tendency a map (fig. 3) is given of the ratio of the insane per hundred thousand of the population according to the census of 1890. The same situation, to all intents and purposes, is maintained here but is perhaps still better illustrated in figure 4 which shows the location of cities having a

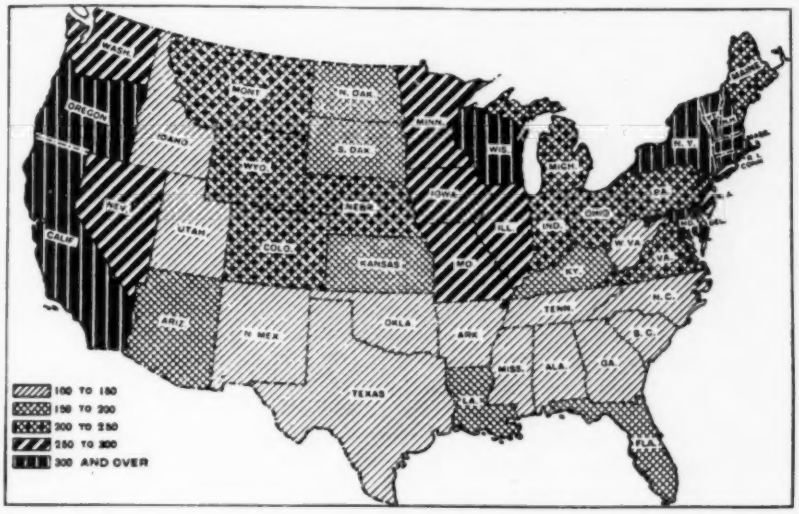

Fig. 3.—Number of patients in hospitals for mental disease, on Jan. 1, 1923, per hundred thousand of the population, by states.

population of 50,000 or more according to the same census. Here again one sees the same kind of map. The location of the cities indicates density of population. This density is greatest in the Northeast, and no matter in which direction one goes it falls off just as did the ratio of the insane.

Density of population and insanity go hand in hand. Mental disease is a disorder of man as a social animal.

A study of later censuses will indicate that the same law holds good, but the distribution of mental disease does not quite so clearly illustrate it. The recent decades have shown a rapid increase in the population of the country as a whole, so that certain local situations have introduced apparent variations. This is shown in the map giving the ratio of

patients in hospitals for mental disease per hundred thousand of the population in accordance with the United States census of Jan. 1, 1923.

The Northeast and the Pacific slope have the highest percentages, and on the whole the South and the Southwest have the lowest, while the Middle West shows varying conditions. Whereas in the early days the westward migration took place along the river valleys, when the population became more congested and transportation facilities more highly developed, a departure from these original pathways was bound to take place. In this map, therefore, while one sees an increasing proportion of mental disease in the states of the Mississippi valley and in the region of the Great Lakes, other things have to be taken into consideration, particularly density of population and local conditions.

As regards density of population, I have already intimated by the location of the large cities that the rate of mental disease is related to this factor. This is shown in table 1 by the five censuses beginning in 1880 and ending in 1920.

TABLE 1.—*Population in the United States, by Decades from 1880 to 1920*

Year	Per Cent Urban	Per Cent Rural
1880	28.6	71.4
1890	35.4	64.6
1900	40.0	60.6
1910	45.8	54.2
1920	51.4	48.6

The relation between the number of mental diseases, expressed in percentages, in the urban and the rural population is recorded in table 1. Throughout these years the percentage of mental disease in the urban population has been gradually increasing, while the percentage in the rural population has been falling off. This picture must be thought of in connection with the general increase in the population throughout the United States and as showing a gradual concentration of mental illness in the large centers of population.

Corresponding with the foregoing statement about the types of persons that migrated from centers of population and those that were left behind, a study of the types of mental illness in the urban and the rural populations shows that the rate of cerebral arteriosclerosis, paresis and alcoholic, manic-depressive and dementia praecox psychoses is markedly higher in urban first admissions, while the ratio of senile psychoses, involutional melancholia and mental deficiency is higher in the rural.

In order that one may get some idea of the extent of mental illness in comparison with other illnesses, I call attention to the number of beds provided in the public institutions throughout the country for this type of patients as compared with the number of beds in other

hospitals. It will be noted that on Jan. 1, 1923, there were approximately 700,000 hospital beds throughout the United States; that was over six years ago, and the returns were not quite complete at that time. I think one may say that in round numbers today there must be approximately 800,000 hospital beds throughout the country. If the proportions in this table hold true, the beds for patients with mental diseases constitute about one-half this number. As one aspect of this problem, it will be noticed that on Jan. 1, 1923, the number of phy-

TABLE 2.—*Occurrence of Mental Disease in Urban and Rural Districts in New York State, from 1915 to 1920* *

Psychoses	Urban First Admissions		Rural First Admissions	
	Number	Average Annual Rate per 100,000	Number	Average Annual Rate per 100,000
Senile	2,535	6.2	596	6.4
Cerebral arteriosclerosis	1,698	4.2	332	3.5
Paresis	3,987	9.8	267	2.9
Cerebral syphilis	186	0.5	24	0.3
Alcoholic	1,510	3.7	152	1.6
With other somatic diseases	839	2.1	125	1.3
Manic-depressive	3,839	9.4	570	6.1
Involutional melancholia	855	2.1	275	2.9
Dementia praecox	7,790	19.1	728	7.8
Paranoia or paranoic conditions	535	1.3	94	1.0
Epileptic	652	1.6	106	1.1
With psychopathic personality	558	1.4	110	1.2
With mental deficiency	702	1.7	202	2.2
All other psychoses	2,696	6.6	392	4.2
Total	28,382	69.5	3,973	42.5

* Those living in cities and villages of 2,500 or more are classed as urban, the rest as rural.

TABLE 3.—*Hospital Beds, Jan. 1, 1923*

Patients	Number Beds	Physicians
Insane	267,617	902
Epileptic	8,777	34
Feebleminded	49,954	109
Total	326,348	1,105
All others	373,475	
	699,823	
Total physicians in the United States in 1927	.....	149,521

sicians in the various state hospitals for the insane, epileptic and feebleminded was only 1,105. This means that although the number of beds for this class of patients was approximately one half of the total number of hospital beds throughout the country, less than 1 per cent of the physicians were engaged in taking care of this group of patients.

Of these three groups of patients, only the insane was even approximately adequately cared for. Many states in the Union have no institutions for the feebleminded or epileptic, and only a relatively small number of those in the community are housed in public institu-

tions. I shall indicate only the economic significance of these figures. On Jan. 1, 1923, the United States had a total investment of $246,348,925.52 in state hospitals for mental diseases, and the annual expense of maintaining these institutions for the fiscal year 1922 was $63,673,159.60. This, of course, represents only a portion of the economic loss to the country from this type of sickness, as those who are in institutions represent not only the cost of the investment in the institution and its maintenance, but also a loss of earning capacity. By far the larger number of admissions to hospitals occur when the patients are at the period of life when they should be at the maximum of efficiency.

This relative proportion of the insane to other patients gives only a part of the picture. Another part, equally important and ordinarily much more alarming, is presented by the actual increase in the numbers of the insane in institutions in relation to the general population. Table 4 shows this relationship. Whereas the proportion of insane per hundred

TABLE 4.—*Patients with Mental Disease in Institutions by Decades, from 1880 to 1920*

Year	Number	Per 100,000, of the General Population
1880	40,942	81.6
1890	74,028	118.2
1904	150,151	183.6
1910	187,791	204.2
1918	223,957*	217.5
1920	232,680*	220.1

* Excluding paroles.

thousand of the general population in 1880 was only 81.6, it rose steadily until in 1920 it became 220.1. This disproportion is still better shown in figure 6. This graph shows that from 1880 to 1920, the population increased 110.8 per cent but the number of patients with mental disease in institutions increased 468.3 per cent. If one undertook to explain this, the first thing would be to determine whether more patients were being admitted than formerly.

Table 5 gives the total number of patients admitted and the rate per hundred thousand of the general population. While of course the total number of patients admitted has materially increased, it will be noted that the rate per hundred thousand has not greatly changed. This is further shown by figure 7, which shows that while the number of patients per hundred thousand in institutions throughout the United States and the patients per hundred thousand in institutions in a single state, New York in this case, have both increased, the admissions to New York state institutions per hundred thousand have remained on a level.

One therefore must reach the conclusion from these figures that the increase in the hospital population is due to an accumulation of patients rather than to any considerable increase in the number who are admitted. It is obvious from these tables and graphs that there is no corresponding relation between the number of patients admitted and the disproportion between the increase in the hospital and the general population. While there has been an increase in the rate per hundred thousand of the patients admitted to the state hospitals throughout the country—from 65 per 100,000 in 1909, including the

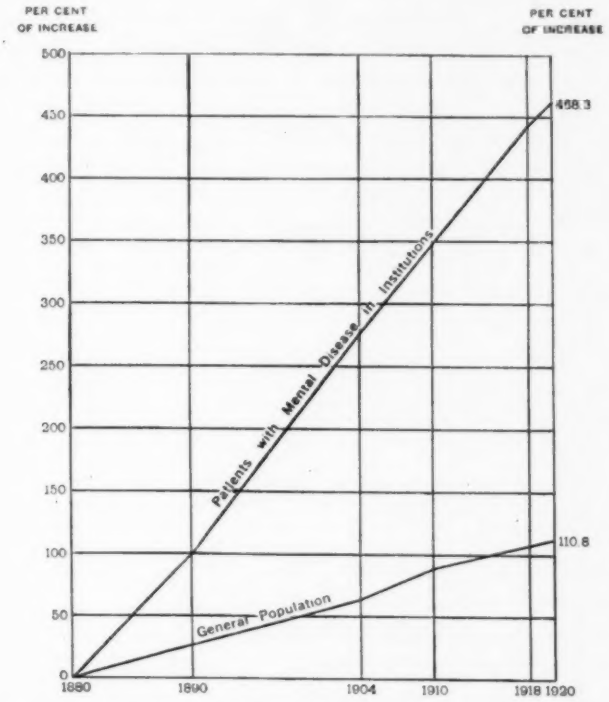

Fig. 6.—Increase of patients with mental disease in institutions compared with increase of general population of the United States, from 1880 to 1920. Note the interval from 1890 to 1904; no special census of patients was taken in 1900.

civil state hospitals for the criminal insane and the licensed institutions, to 73.8 per 100,000 in 1927—this is not nearly as great an increase as the total increase in the number of patients in institutions for mental disease throughout the corresponding period.

EXPECTANCY OF MENTAL DISEASE

All these statistical studies raise the exceedingly important social issue of susceptibility to mental disease and the distribution of this

susceptibility or, to use a more technical term, the expectancy of mental disease. The first thing that strikes one in an inquiry of this sort is the increased susceptibility to mental disease with increasing age. Figure 8 indicates this clearly. From birth to about 15 years of age, the susceptibility is practically zero; then it rises rapidly to the age of 25. From then on to about 55 years of age there is a slow and gradual increase, and then a second rapid rise until the age of 70 and over. This means, of course, that the greatest susceptibility to mental disease is during the period of adolescence and during the declining years of life. The great advances which have been made in recent years in preventive medicine, which have resulted in a material increase in the average length of life, have brought an increasingly large percentage of the population within this second period of heightened susceptibility to mental disease. Obviously, in a population the average length of

TABLE 5.—*Rate, per Hundred Thousand of the General Population, of All First Admissions to the Civil State Hospitals for the Insane, from 1909 to 1920*

Year	Total First Admissions	Rate per 100,000 of the General Population
1909	5,222	58.6
1910	5,564	61.0
1911	5,700	61.8
1912	5,742	61.5
1913	6,061	64.1
1914	6,265	65.4
1915	6,204	64.0
1916 (9 mos.)	4,903	66.5*
1917	6,877	69.0
1918	6,797	67.3
1919	6,791	66.3
1920	6,573	63.3

* Reduced to yearly basis.

life of which did not exceed 40 years there would be relatively few patients suffering from the depressions of later life, from the arteriosclerotic psychoses, from the senile psychoses and even from paresis, but as this average is increased, a progressively larger portion of the population live into this period and therefore contribute their quota to patients with these psychoses.

Several years ago, the late Dr. Thomas W. Salmon,[2] interested in the question of the expectancy of mental disease, attempted to discover what proportion of the population became patients in hospitals for mental disease in the course of a generation. He attempted to answer this question by comparing the deaths in a single year in the New York state hospitals for mental disease with those in the general population. He found that in a given year one death in every twenty-two of those reported to the New York State Health Department

2. Pollock, Horatio M., and Malsberg, Benjamin: Expectation of Mental Disease, Psychiatric Quart. **2**:549 (Oct.) 1928.

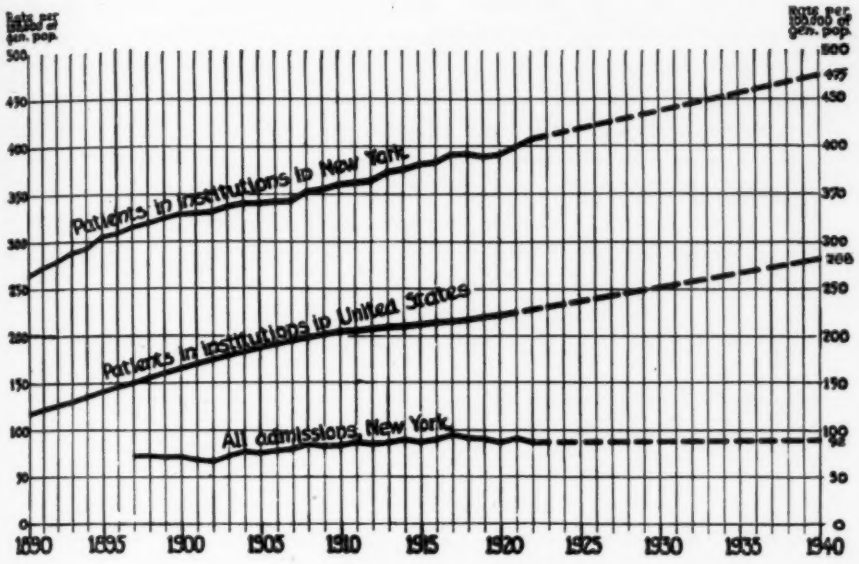

Fig. 7.—Trends in rates of mental patients in institutions in the United States and New York, from 1890 to 1922, and of all admissions in New York from 1897 to 1922.

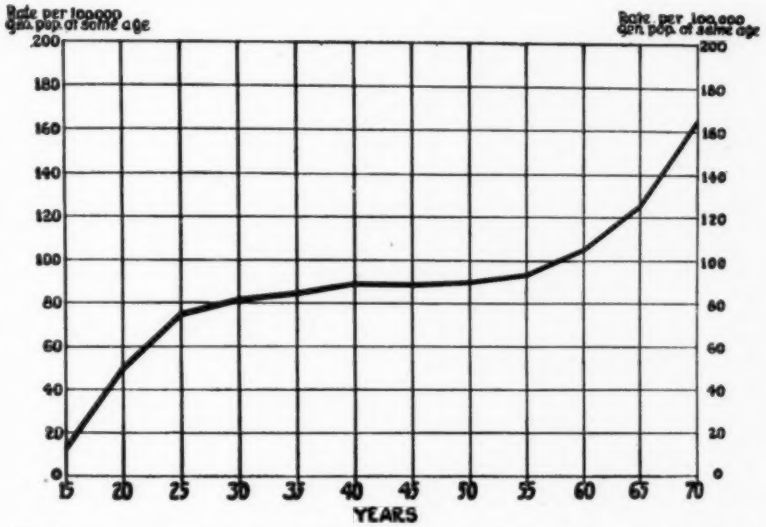

Fig. 8.—Increase of rate of mental disease with advancing age among first admissions in New York in 1920.

occurred in hospitals for mental patients. Comparing the deaths in these hospitals with the admissions, he found that there were approximately twice as many admissions as deaths, and concluded from this that about one of every ten or eleven persons became mentally ill in the course of a generation, an estimate which was proved by more careful later investigations to be much too high. The later investigation, conducted by Dr. Horatio M. Pollock, statistician of the New York State Department of Mental Hygiene, and his associate, Benjamin Malsberg, showed that, roughly speaking, at the time of Dr. Salmon's inquiry the crude data gave the proportion of those becoming mentally

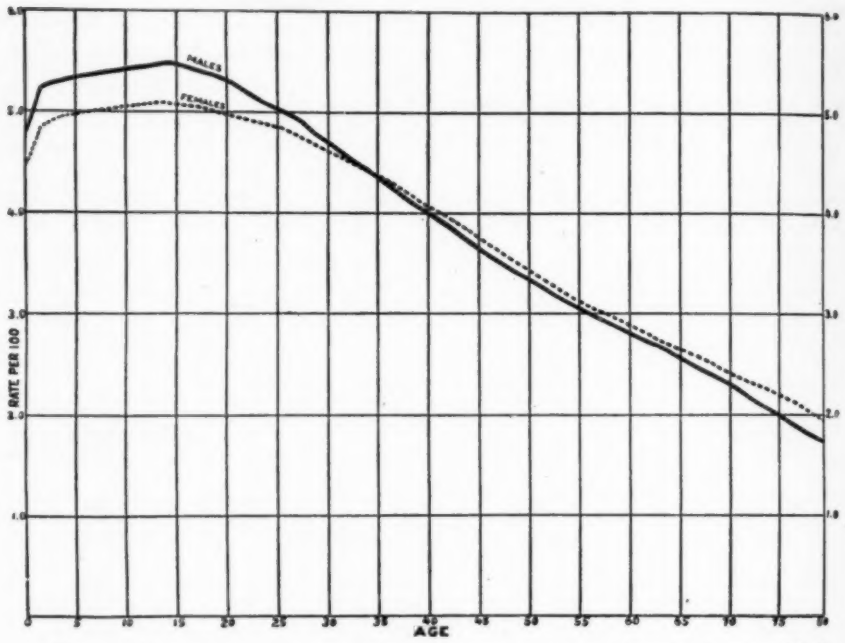

Fig. 9.—Expectation of mental disease among males and females in New York State per hundred alive and sane at specific ages.

ill in the course of a generation as approximately one in twenty-five. The more detailed study of this situation is shown in figure 9.

The graph in figure 9 gives the expectation of mental disease in New York State per hundred persons alive and sane at specified ages. It shows that the expectation at birth of males exceeds that of females, being 4.7 for the former and 4.4 for the latter. These figures increase to a maximum at the age of 15 years of 5.5 for males and 5.1 for females, and in succeeding years there is a steady decrease. From the same study the rates of mental disease in New York State per hundred thousand of the same age and sex are shown in figure 10.

which has almost exactly the same characteristics as the graph in figure 8, showing as it does the rapid rise during the adolescent and the presenile and senile periods. At birth, therefore, according to these figures, the expectancy is in uncanny agreement with Salmon's rate of 1:22, which he discovered by examining the death certificates, and certainly gives a picture which without correctives would be appalling. To quote from the language of the study referred to:

> It appears that approximately 4.5 per cent of the persons born in the State of New York may, under existing conditions, be expected to succumb to mental disease of one form or another, and become patients in hospitals for mental disease. In other words, on the average, approximately one person out of twenty-two becomes a patient in a hospital for mental disease during the lifetime of a generation.

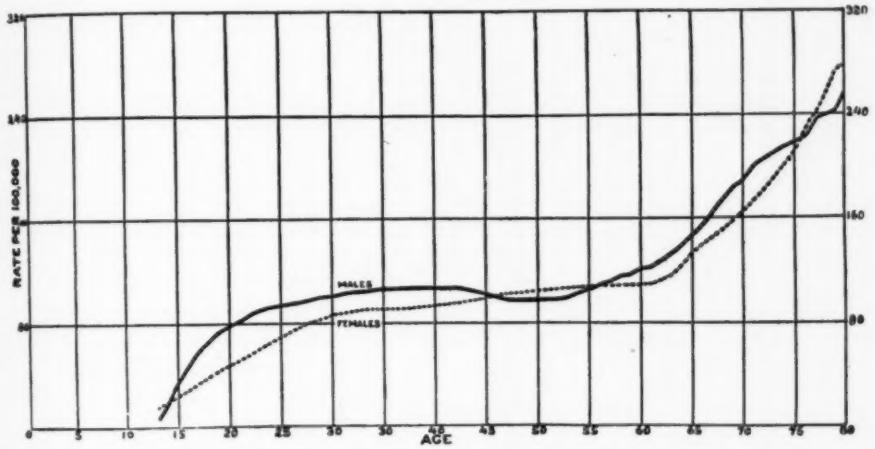

Fig. 10.—Rates of mental disease in New York State per hundred thousand of the population of the same age and sex.

As bearing on the increase of patients in institutions for mental disease, the general death rate per thousand patients under treatment in hospitals for mental disease throughout the United States in 1922, including 25,436 deaths reported, was 74.3. Comparing the deaths with the admissions, however, one finds the deaths 27.7 per cent of the total admissions, whereas the number of discharges, excluding deaths and transfers, was only 58.4. This corroborates my former statement that the increase in the number of patients in institutions is made up largely as the result of accumulation. The average age at death, namely, 55.3 years, is nearly the same as that of persons dying in the general population; yet, as stated by Pollock, it must be remembered that patients with mental disease are in the main adults.[3]

3. Pollock, Horatio M.: Outcome of Mental Diseases in the United States, Mental Hygiene **9**:789 (Oct.) 1925.

A further study of the death rates among the insane indicates that there is a discrepancy between them and the death rates in the general population. Table 6, taken from the Metropolitan Life Insurance records,[4] shows that for each quinquennial period from 17 to 87 the death rate per thousand is much larger among the insane group than among the general population. This is still more graphically shown in tables 7 and 8 taken from the Federal Census reports.

TABLE 6.—*Death Rates per Thousand of the Insane in New York State Hospitals from 1914 to 1923, Compared with Death Rates of the General Population for 1919 and 1920 in New York State by Sex and Age*

Sex, Age	Death Rates per 1,000		Ratio of Death Rate of Insane to That of General Population
	Insane	General Population	
Male			
17	53.15	3.95	13.5
22	51.82	5.38	9.6
27	57.05	6.27	9.1
32	72.81	7.39	9.9
37	87.76	8.41	10.4
42	93.87	10.04	9.4
47	95.11	12.69	7.5
52	102.61	17.11	6.0
57	112.04	24.83	4.5
62	137.28	34.35	4.0
67	193.97	50.09	3.9
72	241.67	73.08	3.3
77	356.48	105.93	3.4
82	490.00	156.03	3.1
87	700.00	206.86	3.4
Female			
17	68.79	3.43	20.1
22	80.72	5.28	15.3
27	61.79	6.60	9.4
32	64.81	6.74	9.6
37	59.08	6.73	8.8
42	57.62	8.11	7.1
47	58.86	10.66	5.5
52	67.53	14.40	4.8
57	71.44	21.42	3.3
62	92.07	29.64	3.1
67	129.68	46.70	2.8
72	190.18	69.40	2.7
77	253.61	98.63	2.6
82	355.00	140.30	2.5
87	500.00	199.05	2.5

From tables 7 and 8 it is seen that the total average death rate per thousand for the general population is 13.1, while that for patients in institutions for mental disease is 74.3. These tables show a state of affairs which I am sure is little suspected, because one of the outstanding expressed fears regarding mental disease has been for years that the public institution is keeping the stock from spontaneously perishing as it would without care, and therefore is replenishing the potential insane group in each generation. This was expressed by the phrase "preserving the unfit," and was supposed to be an essentially dangerous procedure for the future of the race. According to these

4. Metropolitan Life Insurance Company: Statistical Bulletin, vol. 9, May, 1928.

figures, however, not only does one see that the death rate among patients in hospitals for mental diseases is much greater than it is in the general population, but one should realize that this is so in spite of the fact that the hospitals are calculated to protect these particular types of inefficient personalities and to do so not only by ordinary medical means but by creating a simple environment that produces the minimum of stresses to which they are called on to adjust themselves. Even with all this care, the death rate is between five and six times greater than that in the general population. Wherever one

TABLE 7.—*Death Rates per Thousand by Age Groups Among the General Population of the Registration Area of the United States, 1920*

Age Groups	Male	Female	Total
15 to 19 years	4.2	4.0	4.1
20 to 24 years	5.4	6.0	5.7
25 to 34 years	6.5	7.2	6.9
35 to 44 years	8.4	8.1	8.3
45 to 54 years	12.6	11.8	12.2
55 to 64 years	24.9	22.8	23.9
65 to 74 years	54.7	50.7	52.7
75 years and over	137.4	133.0	135.1
Total	15.5	12.7	13.1

TABLE 8.—*Death Rates per Thousand Under Treatment by Age Groups Among Patients in Institutions for Mental Disease in the United States, 1922*

Age Groups	Male	Female	Total
Under 20 years	35.3	37.4	36.2
20 to 24 years	32.2	44.1	36.7
25 to 29 years	30.2	44.2	35.8
30 to 34 years	42.1	43.5	42.7
35 to 39 years	56.9	44.4	51.4
40 to 44 years	65.3	46.4	56.6
45 to 49 years	66.2	50.0	58.4
50 to 54 years	74.6	50.7	62.7
55 to 59 years	87.8	58.2	73.2
60 to 64 years	112.7	74.9	93.9
65 years and over	214.3	165.1	189.1
Total	80.1	67.4	74.3

finds a force at work tending to destroy a species one will also find a counter force developed to preserve it.

One may examine this situation somewhat more in detail by inquiring into the death rates of the different major types of psychotic reactions. At Saint Elizabeth's Hospital the psychoses were divided for purposes of study into four major groups, namely, the paranoid, the cycloid, the schizoid and the epileptoid, the cycloid including the manic-depressive group and the schizoid the dementia praecox group. In the United States census reports for 1923, the death rate in the hospitals for mental disease during 1922 is as shown in table 9. It must be understood that the correspondence between these four groups and the four groups studied under the same names at Saint Elizabeth's Hospital

is not exact, but I think it is sufficiently so, because if the disagreement were corrected, the figures would be more rather than less striking. Here one sees that the highest death rate is found in epilepsy, the next highest in dementia praecox, the next in the manic-depressive psychoses, while in paranoia the age at death corresponds well with, in fact somewhat exceeds, the average age at death of the general population. Realizing that the population of these hospitals is essentially an adult population, I have compared the nearest quinquennial age in the life expectancy tables to the age on admission of these four classes of patients. It will be seen from this comparison that they all died considerably earlier than they should have in accordance with these tables.

The two features brought out by table 9 are: 1. Patients in hospitals for mental disease have a higher death rate than the general population, which is the conclusion drawn from previous statistics that I have presented. 2. Among the four great groups of psychotic reactions there appears to be a gradation in malignancy, paranoia being the

TABLE 9.—*Death Rates for Special Psychoses in Hospitals for Mental Disease, 1922* *

Psychosis	Age at Death	Age on Admission	Expectancy of Life		
			Age	Male	Female
Paranoia	61.4	45.5	50	21.10	22.55
Manic-Depressive	50.8	39.3	40	28.84	30.56
Praecox	46.5	32.2	30	37.11	38.86
Epileptic	42.9	33.7	30	37.11	38.86

* Total number of deaths covered by table is 25,436.

least malignant, manic-depressive insanity the next, followed by dementia praecox, and finally by epilepsy. These facts coincide accurately with the concept formed as to the nature of these psychotic reactions as they have been observed at Saint Elizabeth's Hospital.

If the suggestion contained in these statistics is correct, one would expect to find further confirmation in the statistics of the death rates in epilepsy uncombined with psychoses, as one sees it in institutions for epileptic and for feebleminded patients. The United States Census reports show that the ages of patients dying in institutions for epileptics show little variation in the distribution between the two sexes, except that in the group from 20 to 24 years of age, the rate for the females is much lower than that for the males. With this exception there is a fairly uniform number of deaths in the quinquennial groups to 55 years or over. The median age group for each sex is from 35 to 39 years and the report contains the following comment on this fact: "This comparatively low age at death supports the belief that epilepsy greatly shortens life."

If one consults the census reports in regard to the death rate of the feebleminded, one will find: 1. Of the patients who died in institutions for the feebleminded in 1922, 50.4 per cent were under the age of 20 and only 4.5 per cent were over the age of 60. The percentage of deaths of persons under 20 years of age among the males was 54.3, and among the females 45.3. The highest number of deaths among patients of any age group occur in the age group from 15 to 19 years. 2. The age of the patient population in institutions for the feebleminded is comparatively young, 65.7 per cent being between the ages of 10 and 30 years, and only 1 per cent above the age of 60. While the death rate among the feebleminded is much higher than among the normal population, the difference becomes less marked when the factor of age is taken into consideration. The death rate among the feebleminded varies with the degree of mental defect, the general average age among idiots, imbeciles and morons per thousand under treatment in 1922 being 68.7, 26.7 and 10.1, respectively. The death rate in each mental status group is higher among males than among females. The death rate among the moron group approximates the death rate in the general population.

Thus one sees that if one were to complete table 9 it would show that epileptic patients as such have a still higher death rate than epileptic patients in institutions for mental disease, and that the feebleminded have a still higher death rate. The death rate of the feebleminded again presents a gradation, the death rate of morons approximating most closely that of the general population, that of imbeciles being more than two and one-half times as high as that of morons, and that of idiots being between six and seven times as great as that of morons.

I am aware that this general conclusion, which the figures from the census reports warrant, is not the conclusion that has been reached by certain investigators, notably by the Eugenics Record Office of the Carnegie Institution of Washington which studied the birth and death rates of the feebleminded and came to the conclusion that the death rate among the offspring of feebleminded women is not higher than that to be expected for the general population, and that the number of offspring of the feebleminded more than replaces the probable parental group. I do not think that the statistics of the Census Bureau and of the Eugenics Record Office are comparable as to the nature of the records studied.[5]

At any rate, I feel that it must be true that the defectives in the community would die at a very early age if they were not specially

5. Green, Charles V.: Birth and Death Rates of the Feeble-Minded, Washington, D. C., Carnegie Institution of Washington, Eugenics Record Office, bulletin no. 26.

provided for. It is obvious that an idiot would soon starve to death or die of exposure if he were not fed and protected, and that in the absence of care and protection the liability to die would vary directly in accordance with the degree of mental defect.

At this point I may mention some additional factors of importance and social significance bearing on this question of capacity to survive and perpetuate their kind as applied to these several groups.

It has been assumed that the feebleminded mate at random. This is obviously not true. Fisher,[6] after a careful examination of the whole question, came to the conclusion that the feebleminded, instead of constituting 1 in 320 taken at random in the general population, may better be regarded as constituting one sixteenth of an intermating group consisting of 5 per cent of the general population. He came to this conclusion by calculations which showed that if the factor of feeblemindedness were really scattered at random, only 5.5 per cent of the parents of the feebleminded would themselves be feebleminded; whereas if the factor were concentrated, as he has assumed, 25 per cent of the parents would be feebleminded. In an analysis of 325 cases by Major Darwin, the actual number of feebleminded parents was found to be 29.5 per cent. On the basis of these figures, Fisher concluded that the effect of segregation, because of the concentration of the defect in a limited number of strains, might produce as high a reduction of the incidence of feeblemindedness as 36 per cent in one generation.

With further reference to the perpetuation and mating of the feebleminded, Popenoe, in a series of articles on eugenic sterilization in California[7] concluded: "The marriage rate of the psychotic of both sexes is markedly below that of the general population of all ages."

The results of these studies, therefore, indicate that not only is the death rate for all these groups notably higher than that for the general population but the additions to the group are notably less, at least by way of the legitimate institution of marriage. It is probable that the illegitimate route does much to keep the level about the same, at least in some instances.

These various factors would seem to indicate an additional general principle; namely, that a compensating eugenic factor will also be uncovered wherever a dysgenic factor is found at work.

The foregoing figures might be criticized on the basis that they refer only to statistical groups, vague and ill defined. It is true that these groups are ill defined in the sense of being clearly formulated; on the other hand, they are the results of certain fairly widely diffused

6. Fisher, R. A.: J. Heredity **18**:529 (Dec.) 1927.
7. Popenoe, P.: J. Nerv. & Ment. Dis. **68**:17 (July) 1928.

feelings on the part of society from which fairly uniform actions result. Perhaps this sort of conformity is, after all, better than formulation. Beyond this, however, I have indicated certain uniformities in the reactions of these statistical groups which indicate that my surmises, as outlined, have some basis on fact: that there is an underlying uniformity that runs through each group and justifies the classifications that have already been made. It is a situation similar to that found in biology in which a study of the blood of various species of animals bore out the opinions of their relationship which had already been reached by other methods. It is a fascinating concept that would carry the peculiarities of mental reaction down through the whole living organism, as it were, to all its parts and functions.

ASSOCIATION OF PSYCHOLOGIC AND SOMATIC TYPES

It will be noted, however, that there is no hope of discovering these differences in accordance with the old ways of considering and of thinking about living beings. It will be possible, if it ever is, only by changing all stereotyped and usual ways of thinking. When one approaches the problem with an entirely altered vision that has become not only keener but more far seeing and broader in the process of change, one stands some chance of discovering what heretofore has escaped observation. When it is possible to do this, one will undoubtedly be on the way to as complete an about face as was witnessed when the planetesimal hypothesis of Chamberlin and Moulton replaced the theory of the origin of the solar system formulated on the nebular hypothesis of Laplace. It is just such a revolution of the usual way of thinking when I ask you to replace the old ways of thinking of the relations of mind and body with the concept that a person who has a compensatory psychosis will show in his more organic, bodily types of reaction the capacity for developing a compensatory somatosis, and that conversely a decompensating psychosis will show a decompensating type of somatic reaction. The relation here, so far as it is proper to speak of a relation between two parts which are not parts but only aspects of the whole, is purely functional and, no longer satisfied with lip service to the concept organism-as-a-whole, one recognizes that at any given moment of any kind of reaction it is in reality the whole organism that reacts.

The following is a passing reference[8] to the factual basis for such an assertion in order that it may not be regarded as wholly a philosophic speculation: It has been found that stimuli to certain sensory areas actually do effect alterations in the appreciation of stimuli by other

8. Malamud, W., and Rothschild, D.: Some Modern Tendencies in Neurophysiology and Their Relation to Neuropsychiatry, J. Nerv. & Ment. Dis. **68**:231 (Sept.) 1928.

sense organs. When the arm of a patient with cerebellar disease deviates outward, the ipsolateral pain, touch and auditory stimuli are localized too far laterally. Cooling the skin of the side of the neck with ethyl chloride or an auditory stimulus arranged to affect one ear more than the other produces changes in the tonic reactions of the whole body. Movements of the eye and the visualization of an object at one side or the other definitely influence the tonic reactions of the arms. In some patients with marked tonic changes, visual images are systematically distorted under the influence of these purely motor disturbances.

This interplay between sensory and motor stimuli, ordinarily thought of as distinct as mind and body and not recognized as only conveniences of classification, is seen at once in a new light when one learns to think of the organism-as-a-whole in its true functional significance. Similarly, it is my thesis that the interplay between the organism and its social environment is conditioned just as exactly, and that therefore the future holds in store a knowledge of the social aspects of mental disease which, while far more elaborate and exact than at present, will correlate with the more restricted concepts of the disease pictures as they are at present and as they have come to be formulated in more generic terms as the several mental diseases.

In order that I may make these statements more easily understood, I would call attention to some results that have followed the investigations, conducted by Dr. Freeman at Saint Elizabeth's Hospital.[9] It will be remembered that the psychiatric patients were divided into four great groups: the paranoid, cycloid, schizoid and epileptoid.

Figure 11 shows the incidence of tuberculosis in these groups, and it will be seen that tuberculosis is three times as prevalent in the schizoid groups as in all the other three groups together. This fact is significant but has long been known. I have already indicated my interpretation of it, which is that the schizoid psychoses are, from a psychologic point of view, noncompensatory or decompensating in type; that is, the patient with dementia praecox, who has been included in the schizoid group (for the paranoid types of dementia praecox are classified with the paranoid group), on the whole shows little active tendency to get well or to develop a compensatory type of psychologic reaction—in the way of a delusional system, for example. In other words, he succumbs to the stresses that bring about his psychosis and deteriorates; or, as the older psychiatrist used to say, he dements. In harmony with this type of reaction at the psychologic level one finds at the somatic level a similar type of reaction to the tuberculous infection. Such persons not only are easily infected, relatively speaking, but easily die of tuberculosis. They

9. Freeman, Walter: Biometrical Studies in Psychiatry; III. The Chances of Death, Am. J. Psychiat. **8**:425 (Nov.) 1928.

show no ability to protect themselves from its ravages. They neither get well nor develop a fibrosis, which results in a slowly progressing chronic type of infection. Such a fibrosis is analogous at the somatic level to the type of compensation that I have shown at the psychologic level. A psychosis that is noncompensatory at the psychologic level occurs in a person of noncompensatory type at the somatic level. It is significant, too, that both types of reaction, the psychologic and the somatic, may be properly classified as regressive. This is somewhat too complex a matter to discuss in this paper, but, briefly speaking, the regressive tendency is shown at the psychologic level by the development of simpler mental mechanisms and simpler mental content, whereas at the somatic level, in similar fashion, the highly complicated parenchymatous tissues tend to be replaced by much simpler interstitial types.

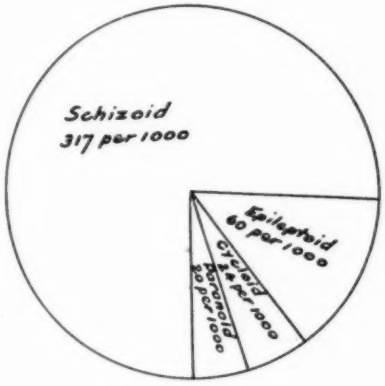

Figure 11

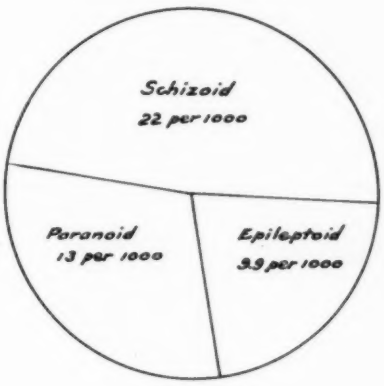

Figure 12

Fig. 11.—Comparative incidence of active tuberculosis.

Fig. 12.—Comparative incidence of deaths due to intestinal catastrophes.

Figure 12 shows the deaths due to intestinal catastrophes. Here again one finds a great preponderance of schizoid persons, practically half the deaths being among these, and the other half being nearly equally divided between the paranoid and the epileptoid type. The figure is noteworthy because of the complete absence of the cycloid type. This, I believe, is another instance of the general kind described in the case of tuberculosis, but with somewhat different mechanisms. Here death is due to a situation which is more or less dependent on the general bodily habitus. The long intestinal tract in a person of poor, soft, flabby musculature makes this type of death more frequent in the schizoid group. The flabby musculature and the long intestinal tract are indications of a type of person who is given more to thought than to action, who is introverted and vegetative rather than extroverted

and aggressive, whose interest is centered in himself and in his own thoughts rather than in others and in the environment.

Figure 13 shows the incidence of malignant tumors so far as they could be disclosed at autopsy. Probably a number of microscopic growths went undiscovered, but the figures indicate clearly that the persons who suffer from malignant conditions are of the paranoid and the cycloid types, the schizoid and the epileptoid group contributing relatively few. This figure indicates a state of affairs diametrically opposite to that shown in the previous two figures. The rareness of the occurrence of carcinoma in epileptic persons has been known for some time, but its frequency in the paranoid and cycloid types has not heretofore been generally recognized. Dr. Lewis, of Saint Elizabeth's Hospital, was the first, as far as I know, to call attention to the asso-

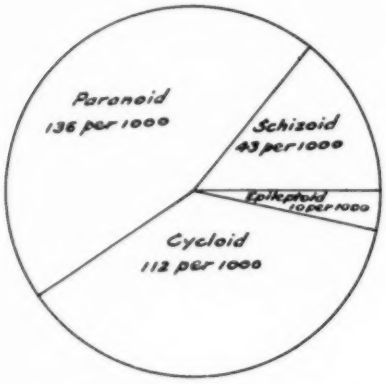

Figure 13

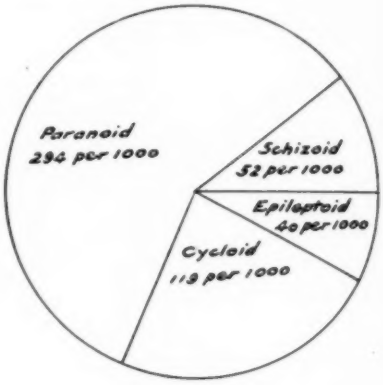

Figure 14

Fig. 13.—Comparative incidence of carcinoma and other malignant tumors.

Fig. 14.—Comparative incidence of chronic streptococcus infections.

ciation of malignant tumors with psychoses that are compensatory or hypercompensatory in type. The analogy here is as fascinating as that between a delusional system which grows at the expense of the personality and a group of cells that grows at the expense of the body; or, as Lewis puts it, "Cancer is paranoia at the cellular level." This association is to my mind sufficiently significant not only from the psychiatric point of view but also from the point of view of cellular pathology, so that even if carcinoma should ever be found to be associated with a microorganism as an etiologic factor, the proliferative type of reaction would be just as significant.

Figure 14 shows the comparative incidence of chronic streptococcic infections in the four major psychotic groups. Here again the picture is not unlike that disclosed by the frequency of malignant tumors. A

productive type of inflammation occurs predominantly in persons who present compensatory types of psychosis, namely, the paranoid and the cycloid, the schizoid and the epileptoid types again contributing few representatives to this group.

Finally, in figure 15, I call attention to the distribution of deaths due to circulatory disasters. Here again, one sees the association of a compensatory psychosis and a compensatory somatosis. The preponderance of the paranoid group is here strongly in evidence, the cycloid group coming second. In this connection one thinks of the chronic streptococcic infections of the kidneys with hypertension, which not infrequently terminate in vascular occlusions or ruptures. This sort of death in the cycloid and paranoid groups has been noted by many observers, but has been particularly stressed by Lewis.

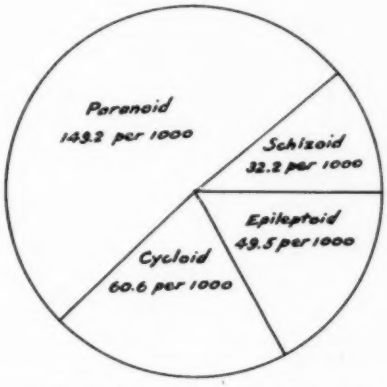

Fig. 15.—Comparative incidence of deaths due to circulatory disasters.

I might add other figures to show the incidence of other diseases in these groups, but I have indicated those which are most significant in relation to the four psychotic types of reaction.

In further comment on this association of psychologic and somatic types, I would call attention to the fact that recently the whole question of constitution, which has come up for consideration from time to time throughout the history of medicine, has come into prominence again, particularly as the result of Kretschmer's work. Among other types, Kretschmer described fully two which at the psychologic level correspond to the schizoid and the cycloid types. These he termed the asthenic and the pyknic, respectively. In figure 16, the picture of an asthenic type is given in profile. This type is characterized by a deficiency in thickness, but not in length, of all parts of the body—face, neck, trunk and extremities—with similar deficiencies in skin, fat, muscle, bone and vascular system. The chest is long, narrow and flat; the ribs are easily counted, and the costal angle is sharp. The stomach is thin and devoid

of fat. The skull is small in circumference, short and broad. The face from the front is a shortened egg form; in profile it is angular, with a long nose and a hypoplastic underjaw. This, in pure culture, is the make-up of the typical noncompensatory, regressive type of schizophrenic person, and it is the physical make-up that has long been associated with tuberculosis. I think it will be admitted that this type looks as if he might easily be susceptible to intestinal catastrophies, such as intussusception.

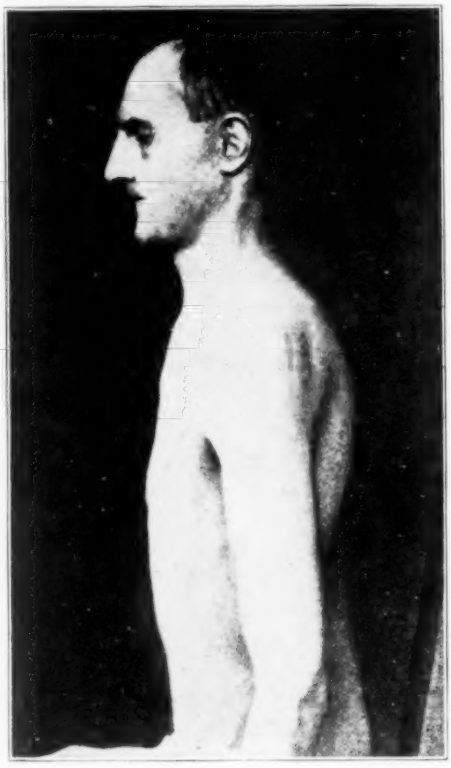

Fig. 16.—Asthenic type.

Figure 17 shows Kretschmer's pyknic type, also in profile. This type is characterized by the pronounced peripheral development of the body cavities (head, breast and stomach), a tendency to a distribution of fat about the trunk and a graceful construction of the motor apparatus (shoulders and extremities). In general, the man is of middle height and rounded figure, with a soft broad face on a massive neck sitting between the shoulders. The magnificent fat paunch protrudes from a deep vaulted chest, which broadens out below. The limbs are soft and rounded, with little muscle or bone relief, often quite delicate. The

joints of the hand in particular are often slim and almost elegantly formed. The shoulders are not broad, but rounded, high, and pushed forward together and often set down against the breast with a characteristically sharp depression on the inner deltoid curve. The shoulders seem to be slipping downward and inward over the swelling chest, the neck seems to disappear, and the upper spine is slightly kyphotic. The point of the chin is directly joined with the upper part of the forehead without

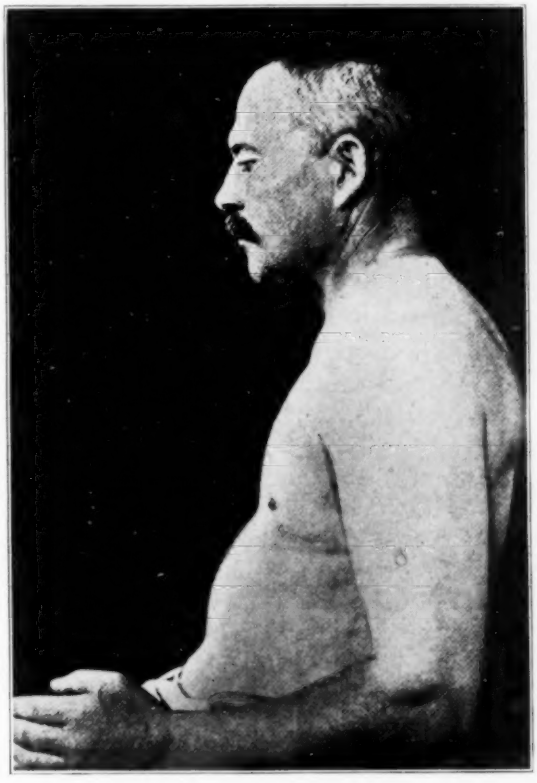

Fig. 17.—Pyknic type.

any definite bends by a sloping line. The proportions of breast, shoulder and neck, the shape of the head and face and the disposition of the fat are characteristic. From the front, the face is of a smooth five-cornered or shield-shaped type. The skull is large, round, broad and deep but not very high.

Whatever else may be said about these types, it seems definite that in relatively pure culture they correspond on the physical side to the types of reactions that are seen in the schizoid and the cycloid personalities at the psychologic level. One is therefore confirmed in the

hypothesis, which I have already briefly referred to, that the characteristics of the person at whatever level he is examined will be found reflected in all the other levels, in other words, throughout the organism as a whole; or, to use the language which I have already used, a person who presents the capacity for compensatory reaction will be found to present this capacity not only in his somatic reactions but also in his psychologic reactions.

If this general conclusion is true, it might also be expected that the same type of reaction would follow through at the social level. Persons capable of compensatory reaction ought to be able, according to this theory, to make social adjustments of a compensatory character, and those not capable of compensatory types of reaction might be expected to fail in any such effort. This I believe to be true. Mental disease has been too little regarded from the social point of view. The delusional systems and various types of psychologic reaction which the psychotic type shows have been thought of too much as individual affairs, but the recent studies in the realm of psychopathology have indicated clearly that this is not an adequate envisagement of their reactions. The psychotic person is struggling with inner conflicts that are dealing with the stuff out of which his ideals have been built up; these ideals are part and parcel of the cultural milieu into which he was born and have been transmitted to him by certain individuals, usually the parents, who thus represent society.

Culture, as I have used the word, is as much a precipitate of man's experience as is his bodily structure. It consists of what collectively are known as the mores—the customs, traditions and beliefs which have been transmitted from generation to generation, as well as the more definitely structuralized institutions—these beliefs and institutions have been developed by man in his struggle with his unrelenting environment for the purposes of handling the problems which that environment has presented to him. The mores and the institutions of civilization are therefore as truly structures for the handling of reality as the various organs of man's body are structures for handling problems of reality at the somatic level. Just as commerce has been built up for the handling of the commercial relations between people, the exchange of material between one and another in accordance with their respective needs, so the liver, for example, has been built up to handle the question of the way in which the organism must deal with carbohydrates.

Professor Schilder in a recent work said:[10]

> Of course we might assume with Stärcke that all that is needed in order to eliminate the psychosis is a change of society. But this kind of assumption ignores the fact that it is society also which furnishes the dispute with the world, all those difficulties into which nature and one's fellow men place the individual.

10. Schilder, Paul: Introduction to a Psychoanalytic Psychiatry, 1928.

Those aspects of the ego-ideal which represent society are also the ones which are employed for the mastery of Nature. According to this view, the psychosis constitutes a biological alteration, an altered natural phenomenon, which can not be done away with through a change of society, since the psychosis comes into conflict not only with those aspects of the social order which are of a transitory and absurd nature, but also with those which are the expression of man's ability to master reality. Only through our fellow beings do we ourselves become beings.

Recent field studies in anthropology which show certain primitive peoples as being carefree and happy might seem to indicate that this happiness was due to lack of the many restraints which modern civilized society imposes in various fields of human activity. This association of freedom from restraint and happiness seems to exist, but one must remember that these people are savages, and it is quite as fair to assume that they remain savages because they have failed to subject themselves to the restraints of higher culture as that they are happy because of the lack of that restraint. Just as one found that wherever there were destructive or dysgenic factors at work there were forces of opposite sign correcting their influence, so here one must be careful not to state only one side of the case. It is true that the cultural standards of civilization create forces that make for psychotic developments in individual cases, but it is also true that they create opportunities for personal development far ahead of anything which one finds in the culture of savages. One is dealing here, I am sure, with a fundamental principle, in fact, I believe, a universal law which has been formulated and is known as the theorem of Le Chatelier; briefly stated, this is to the effect that "a system tends to change so as to minimize an external disturbance." If an electrict current is passed through a solution, there is a tendency to the formation of a counter current which thus reduces the electrical stress; suspended particles in a liquid are caused, by a difference in potential, to move in the direction that reduces the electrical stress; photosensitive substances tend to change in a way to eliminate the strain caused by the light; when the wind blows against a tree the boughs bend so as to spill it; animals in a cold climate develop thick coats of fur so as to prevent the radiation of heat; desert plants are very hairy, and by this means, the circulation of air and consequently the rate of evaporation is impeded; the submerged leaves of aquatic plants do not develop the supporting framework of the aerial leaves; an irritant in the eye is washed out by a flow of tears, and in the gastro-enteric tract by vomiting and purging; a serious shortage of men to do a certain kind of work causes a rise in wages and a flow of men to that point to fill the positions, thus lessening the tension of the industrial situation; and plants and trees that have been seriously injured often bloom, thus showing a tendency to limit the destructive effects of the injury.[11]

11. White, William A.: Mechanisms of Character Formation, 1916.

LAW OF AMBIVALENCE

At the psychologic level this law is known as the law of ambivalence, and has many and interesting ramifications. I think I have given sufficient illustrations, however, to indicate the significant conclusion of this lecture which includes all the others; this is to the effect that mental disease always has social significance, and the social maladjustments to which it leads constitute types of reaction that are also manifest in accordance with the same laws at the other levels of functioning. In other words, the same laws hold for the manifestations of reactions at the social, the psychic and the somatic levels.

THE NERVOUS REGULATION OF SUGAR METABOLISM

I. EXPERIMENTAL STUDIES *

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Frank G. Logan Fellow in Medicine
AND
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Considering the voluminous literature concerned with the anatomy and physiology of what one might call the visceral central nervous system in contradistinction to those regions of the central nervous system dealing with somatic functions, one is surprised how few are the really well established facts. It seems as if in the visceral sphere we still were in the "center" period. In the somatic sphere we have passed such a period and have learned how much more complicated matters are and how single nervous functions must always be studied as a part of the whole and not as in an imaginative isolation but shaped by the functional state of the whole organ.

Even terms almost sacred, such as "respiratory center," begin to make one feel somewhat uncomfortable. Circumstances appear still more doubtful with regard to the other so-called visceral centers in the medulla oblongata. Eighty years ago, Claude Bernard [1] punctured the floor of the fourth ventricle in the region of the vagus nucleus and produced glycosuria in the rabbit. He was led to this experiment because his previous work had shown him that stimulation of the central end of the cut vagus leads to such a diabetic effect. If he at any time thought that the piqûre effect was identical with a vagus function, his later experiments showed him that cutting of the vagus did not inhibit the effect of the piqûre. Since, on the other hand, section of the lower cervical cord prevented the glycosuria after piqûre, Claude Bernard concluded that the irritation is transmitted by the sympathetic, causing hyperemia of the intestinal blood vessels. The importance of the sympathetic elements in the physiology of the piqûre, which was verified by later investigators, was in itself hardly compatible with the assumption of a sugar center in the region of the vagus nucleus. Furthermore, the dominating rôle of this region in sugar metabolism became rather doubtful after more and more evidence was acquired that a similar effect could be produced by irritations in other regions of the body. Even Claude

* Submitted for publication, Feb. 27, 1929.
* Read at a Meeting of the Chicago Neurological Society, Jan. 17, 1929.
* From the Division of Neurology of the Department of Medicine, the University of Chicago.

1. Bernard, Claude: Leçons sur la physiologie et la pathologie du système nerveux, 1858; Leçons sur le diabète, 1877.

Bernard knew that glycosuria might occur after cerebral trauma. Other authors were able to show that excitement, pain, sympathetic irritation or operations in different regions had a similar effect, although the effect of such stimuli was still explained as occurring through a medullary center in some way. According to an elaborate review on this whole question in 1920 by R. Allers,[2] there was apparently more evidence against a sugar center in the medulla than in favor of it. The increasing knowledge of the central visceral functions of the 'tween-brain helped to make the existence of lower centers more and more doubtful.

This was the situation when Brugsch, Dresel and Lewy,[3] in 1920, published work in which they claimed to have proved, by means of the first accurate anatomic and chemical study of the piqûre since the work of Claude Bernard, the existence of a center in the medulla for the regulation of blood sugar.

The papers of these authors contain a factor indispensable for reaching a definite conclusion, namely, the first microscopic study of lesions of the medulla made by piqûre. They operated on rabbits with and without ether anesthesia and studied the chlorides in the blood and urine and the blood sugar, but unfortunately not in a conclusive manner. They concluded from their piqûre experiments in rabbits that there is not one center for the sugar metabolism in the medulla oblongata but two; the irritation of one increases, the irritation of the other lowers the blood sugar. This assumption was based to a considerable degree on the observations of Molhant,[4] who found that after cutting the vagus nerve peripherally to the nervus laryngeus superior a number of cells in the central third of the dorsal vagus nucleus remained intact. The same cells underwent degeneration after he had cut a small fiber connection between the ganglion jugulare and the ganglion cervicale supremum of the sympathetic. Brugsch, Dresel and Lewy most arbitrarily assumed that those fibers communicating with the sympathetic trunk belong to the group which innervates the adrenal glands. Relying only on their own insufficient experiments they claimed that the caudal half of the dorsal vagus nucleus is a sympathetic center and its oral end a parasympathetic one. They asserted that extirpation of the pancreas leads to a degenerative process in the oral part of the dorsal vagus nucleus. Thus, a lesion of the oral center is said to lead to pancreatic stimulation and hypoglycemia, while a lesion in the caudal center produces adrenal stimulation and hyperglycemia. The few vagus fibers anastomozing with the sympathetic may be seen in figure 1, taken from Molhant's critical work.

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2. Allers, R.: Ztschr. f. d. ges. Neurol. u. Psychiat. **19**:209 and 321, 1920.

3. Brugsch, T.; Dresel, K., and Lewy, F. H.: Zur Stoffwechselneurologie der Medulla oblongata, Ztschr. f. exper. Path. u. Therap. **21**:2, 1920, Ztschr. f. d. ges. exper. Med. **25**:262, 1921.

4. Molhant, M.: Névraxe, **11**:137, 1910.

No one knows really what function these fibers have, and there is not the slightest reason to consider them sympathetic. They do not even arise, as Brugsch, Dresel and Lewy suggested, from the caudal half of the dorsal vagus nucleus; for the most part they come from some scattered cells in the second quarter of the vagus nucleus. Even excluding this fact, absolutely contrary to the theory of these authors, their work itself does not furnish objective evidence for the presence of one or even two sugar centers in the medulla. Nevertheless, lack of reliable experimental data in the whole field of the piqûre resulted in recognition of their conclusions in most of the modern literature.

Our task was the exclusion of one source of error after the other in analytic experiments in order to find out whether Claude Bernard's

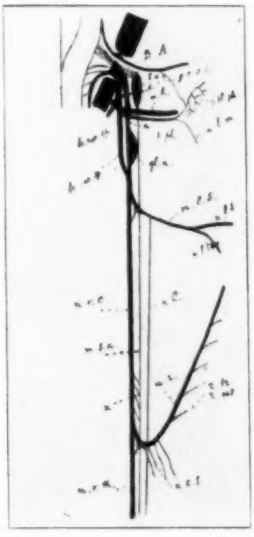

Fig. 1.—The peripheral vagus nerve with its communicating fibers to the cervical sympathetic trunk (after Molhant).

doctrine of a sugar center in the medulla oblongata is correct and if the dorsal vagus nucleus has anything to do with the central regulation of the blood sugar. As to the anatomy of this region the photographs from Winkler and Potter's atlas of the brain of the rabbit should be studied for orientation (fig. 2).

The method of operation first used by us was comparable to that of C. Eckhard [5] and later workers. The subsequent procedure of our experiments was modified as the individual factors of error were recognized and controlled.

5. Eckhard, C.: Beitr. z. Anat. u. Physiol. **4**:153, 1869; ibid. **5**:147, 1870; ibid. **6**:1 and 51, 1872; Ztschr. f. Biol. **44**:407, 1903.

TECHNIC EMPLOYED

Healthy rabbits weighing from 2 to 2.5 Kg. were starved for twenty-four hours. The normal blood sugar was determined on a 1 cc. sample of blood obtained by cutting a marginal ear vein before any manipulation or procedure was begun. The operative region was shaved. The animals were tied on a board in a supine position with the head strongly flexed, and were etherized. The skin was incised in the midline from the occipital condyle to about the first thoracic spine. The posterior muscles of the neck were well separated in the midline, bringing the occipitoatlantoid ligament into view. The dura was cut longitudinally, and the fourth ventricle was exposed.

Puncture was made by a blunt needle into the medulla. The operative wound was then closed only by a few sutures through muscle and skin. A sample of

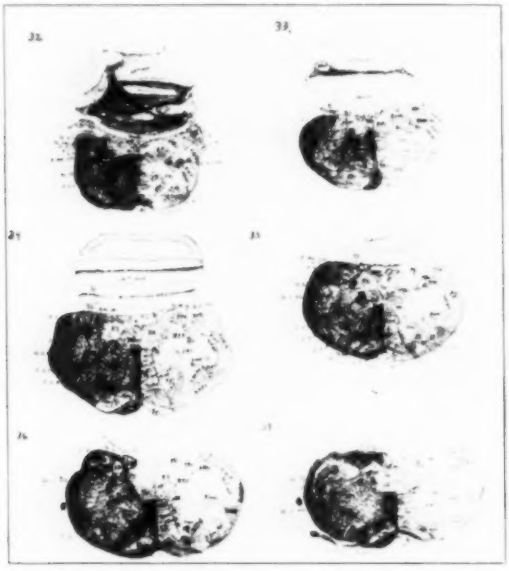

Fig. 2.—Levels XXXII to XXXVII (after the Winkler-Potter Atlas) of the rabbit's medulla.

blood was obtained from the cut vein of the ear immediately after the operation and at varying intervals, designated in the individual curves, for the next five hours. Blood sugar values were determined in milligrams per hundred cubic centimeters on samples of 0.1 cc. by the Hagedorn-Jensen method.[6]

The animals were killed in from one to ten days, the brains removed and a block taken from the upper cervical cord to the lower part of the midbrain. The material was embedded in celloidin, cut in serial sections and stained with toluidine blue.

Rabbits were used partly because they were easily obtainable in sufficient numbers, but primarily because previous experiments of other

6. Hagedorn, H. C., and Jensen, B. N.: Zur Microbestimmung des Blutzuckers mittels Ferricyanid, Biochem. Ztschr. **135**:46, 1923.

authors were performed on rabbits almost entirely. In a series of five rabbits, operated on as described, the blood sugar rose from about 100 mg. to between 207 and 342 mg.

THE EFFECT OF ETHERIZATION

The influence of ether on blood sugar, though widely recognized by physiologists, is a factor apparently underrated by previous workers. There are even statements denying the positive effect of ether on blood sugar. Two rabbits, not tied up, revealed the effect of ether. Figure 3 shows the blood sugar of a rabbit (R 34) punctured as in the first group compared with one (R 30) of the two merely etherized. The increase of the blood sugar in these two experiments is identical or, according to the other experiments of the same kind, at least so similar

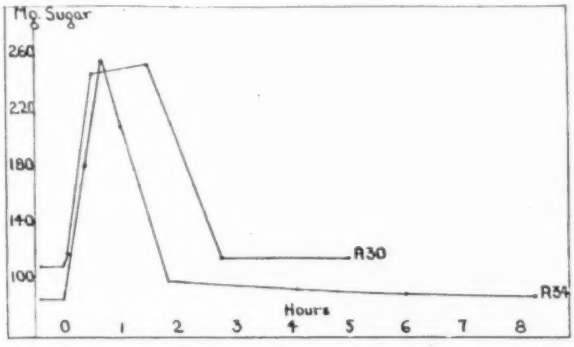

Fig. 3.—The effect of ether narcosis in piqûre. The comparison of hyperglycemia from ether alone (R30) with that of sugar puncture with the animal under ether anesthesia (R34).

that we are entitled to say that ether narcosis prevents the proper evaluation of a sugar puncture.

We then proceeded, performing the same operation on the rabbits without ether narcosis. The rabbits moved and resisted very little. In these twelve experiments the blood sugar rose to levels of from 199 to 307 mg. in nine cases, and to 132, 135 and 163 mg. in only three. Whether the dorsal vagus nucleus was damaged in whole, in part or not at all proved to be of little significance in the character of the sugar curve. If the operation under the same conditions was performed up to the exposure of the fourth ventricle, without touching its floor, the animals showed a rise as high as some of those punctured.

Figure 4 represents the blood sugar of two rabbits punctured without ether (R 17 and 19) and of one (R 40) operated on identically but not punctured.

THE EFFECT OF EXCITEMENT

To rule out factors leading to such a similarity of effect, we had first to take into consideration the excitement of the rabbit brought about by securing it to the table as well as by the operation. The work of Böhm, Hofmann, Cannon, Shohl, Wright [7] and others is indeed suggestive of such an assumption.

Thus in our operations on rabbits we employed ethyl carbonate (urethane), the effect of which has been studied by Bang [8] but is still somewhat disputed. Ethyl carbonate, in a dosage of 1.6 Gm. per kilo-

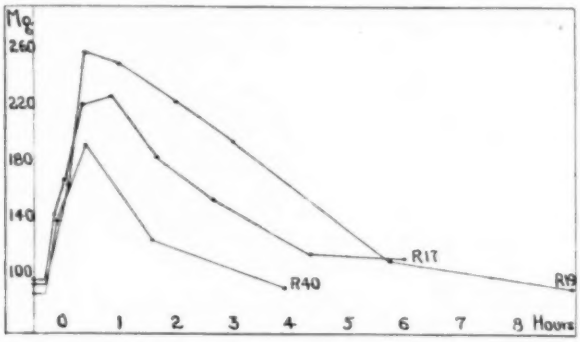

Fig. 4.—The effect of operation and sugar puncture on R 17 and R 19, and operation up to but not including puncture on R 40, all without anesthesia.

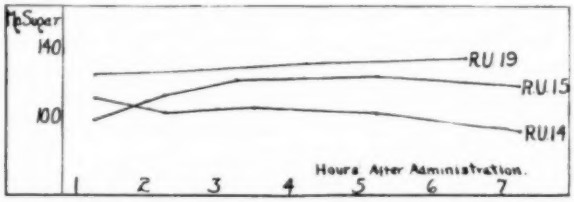

Fig. 5.—The effect of urethane anesthesia in doses of 1.2 Gm. per kilogram of body weight.

gram of body weight, given by stomach tube, in three rabbits (R U 1, 2 and 3) produced a slowly increasing blood sugar up to from 122 to 169 mg. after seven and a half hours. Doses of 1.2 Gm. per kilogram, however, proved to be without such an effect on the animals, as figure 5 shows, but increased somewhat the general level of the blood sugar. Even after as long as fourteen hours, no further rise of the blood sugar was observed (R U 54, fig. 14).

7. Cannon; Shohl, and Wright: Am. J. Physiol. **29**:280, 1911. Cannon, de la Paz: Ibid. **28**:64, 1911.

8. Bang: Biol. Ztschr. **58**:236, 1913; ibid. **65**:283, 1914.

The use of ethyl carbonate helped us to decide whether the strongly positive effect of ether on the blood sugar was due to the excitement of the etherized rabbits or to the pharmacologic action of ether itself. Among a smaller series of rabbits given 1.6 Gm. per kilogram of ethyl carbonate and then etherized for the time an operation usually lasts, we observed rises of blood sugar to 212 and 292 mg. (R U 4 and 5). With the use of 1.2 Gm. of ethyl carbonate we observed, as figure 6 demonstrates, an increase of the blood sugar to 181 and 272 mg. Thus we feel entitled to say that ether increases the blood sugar in rabbits independently of excitement.

THE EFFECT OF HEAD POSITION

Availing ourselves of the possibility of an operation without or at least with little excitation of the animals by the use of ethyl carbonate, we tried to exclude other possible disturbing factors in the experiments.

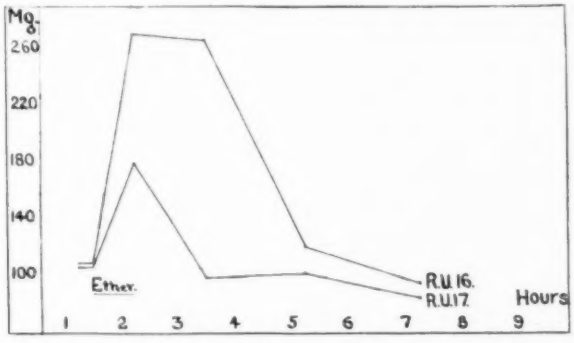

Fig. 6.—The effect of forty-five minutes of ether anesthesia on animals given ethyl carbonate.

First we studied the influence of head-bending on the blood sugar in rabbits under the influence of ethyl carbonate. Rabbits (R U 6, 7, 10 and 11) kept tied on the board with the head bent in a position similar to that during an operation, but for two hours, showed an astounding hyperglycemia of 321, 298, 284 and 340 mg. Obviously, asphyxia might have caused this peculiar effect. The combination of head-bending with a tracheotomy probably could make this clear. We had found that tracheotomy itself caused a definite rise in blood sugar (R U 18), but such a tracheotomized rabbit tied with its head bent, though breathing without any difficulties (R U 21) showed such an enormous rise, identical with the rabbits of the first series, that we had to regard head-bending as an objectionable factor per se and incompatible with controlled experiments on rabbits. Thus in experiments made later, rabbits were operated on in a prone position with the head only slightly flexed and at first under the influence of ethyl carbonate (1.2 Gm. per kilogram).

THE EFFECT OF THE OPERATION

We had so far excluded the effect of ether, excitation and position. Could the exposure itself produce a rise in blood sugar? When we performed operations as before with the animals under the influence of ethyl carbonate but discontinued the operation after having opened the dura without puncturing the floor of the fourth ventricle, we still

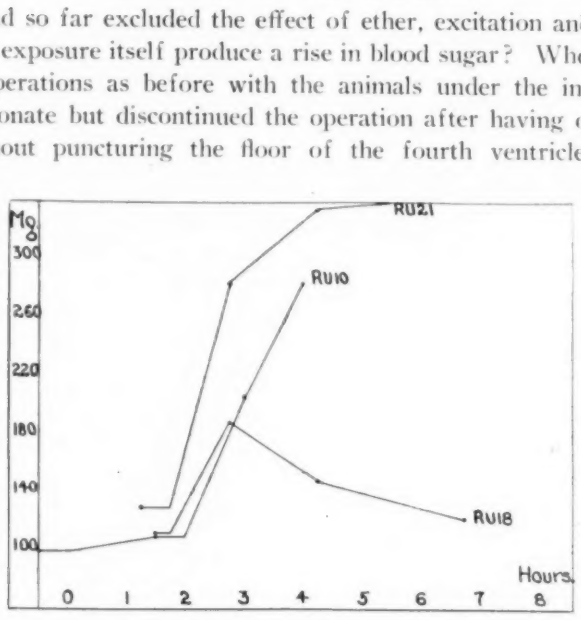

Fig. 7.—RU 10, the effect of head bending alone; RU 18, the effect of tracheotomy alone; RU 21, the effect of tracheotomy and head bending.

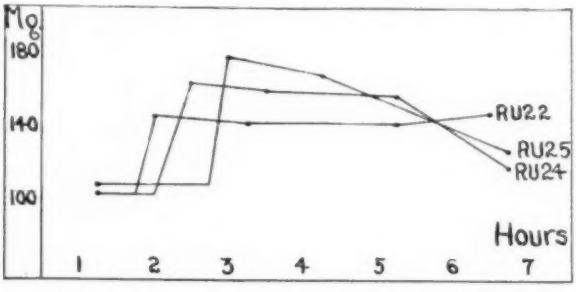

Fig. 8.—The effect of operation and exposure of the fourth ventricle; the animals were not punctured.

observed a hyperglycemia up to 145 and even 180 mg., as shown in figure 8 on rabbits R U 22, 24 and 25.

This result, after all, was not surprising and led to the decision to operate in two stages. This two-stage procedure was also used to compare the effect of variously located operations with that of the piqûre. A larger series of rabbits was operated on in various manners to be described, all in two stages with intervals of from one to two hours, and the second operation was performed while the animal was held quietly

in the lap by an assistant. There was no essential difference between the effect of all these operations. In each experiment the blood sugar, usually dropping from its peak after the first operation, rose again and plainly revealed the additive effect of the second procedures on the blood sugar (fig. 9).

In these experiments the interval between stages of the operation was too short to allow the blood sugar to reach an equilibrium. Thus we were prevented from estimating accurately the exact degree of the hyperglycemia due to the second operation. On the other hand, this experiment shows plainly the tremendous effect of various operative procedures on the blood sugar, compared to which the effect of the piqûre is only moderate. All these curves show the accumulative effect of the different procedures.

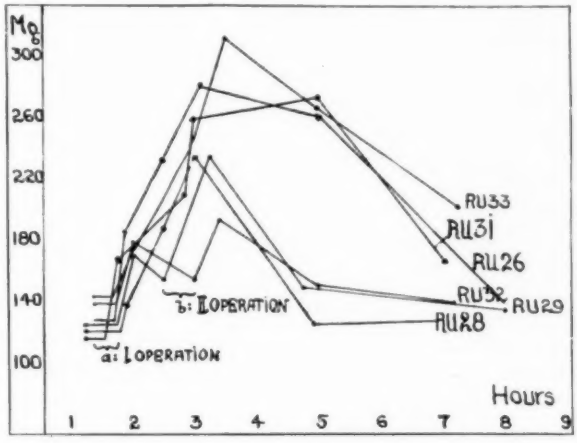

Fig. 9.—Piqûre in two stages, and the effect of other operations and suturing wounds: RU 26 and 28, (*a*) exposure, (*b*) puncture; RU 29, (*a*) exposure to the dura, (*b*) opening of the dura; RU 31, (*a*) exposure, (*b*) suturing of the muscles and skin; RU 32, (*a*) exposure and trepanation of the parietal bone, (*b*) suture of the skin; RU 33, (*a*) laparotomy, (*b*) suture of the peritoneum, muscle and skin.

THE EFFECT OF PUNCTURE IN VARIOUS LOCALITIES

Up to this point it seeemd obvious to us that there were a great number of factors, never sufficiently identified, involved in the hyperglycemia after piqûre. That those factors may become added one to the other in the course of a piqûre operation is evident from our experiments. Moreover, the effect of the puncture of the floor of the fourth ventricle seems to be entirely within the range of effects from other operations. Proof of a sugar center in the medulla cannot be forthcoming without ruling out all the important factors veiling the real results of the piqûre.

There is only one way to determine the effect of punctures of the medulla on the blood sugar and that is to produce a puncture by the two-stage method, either with or without ethyl carbonate narcosis. All disturbing factors of manipulation and exposure are obviated by an interval of at least five, six or more hours before the puncture to allow the blood sugar to reach an equilibrium. The puncture alone, without subsequent suture, packing or manipulation, is performed on the quiet animal which is then returned to its cage. Such was the basis on which we finally set to work to find out the effect on the blood sugar of punctures varying in site and extent in the medulla oblongata. For this purpose the wound was kept open after the exposure with a piece of wet gauze or cotton; in later experiments this sponge was covered with petrolatum to keep the wound moist and less adherent. At first a small series of animals was punctured about five hours after the exposure.

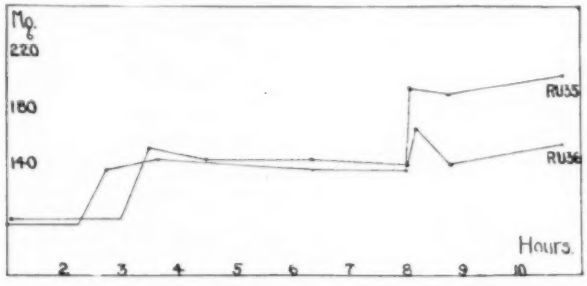

Fig. 10.—Two-stage experiment to show the effect of piqûre five hours after exposure.

Although the blood sugar had not yet fallen to normal, figure 10 shows the effect of two typical piqûres and illustrates again the additive effect of the two operations. At this point of our experiments we felt it necessary to know whether hyperglycemia might occur from the various unavoidable manipulations in the puncture, such as flexing the head, holding the animal, removing the gauze, irritating the muscles, and, as became evident in the later experiments, from some inevitable hemorrhage. We have observed that all of these factors together may result in a rise of blood sugar of about 20 mg. As figure 12 shows, hemorrhage itself does not necessarily increase the blood sugar.

If one minimizes the irritating effect of the removal of the gauze by merely covering the wound, the effect of the sugar puncture decreases proportionally, as figure 13 shows in three rabbits, R U 43, 44 and 45. According to these observations, about 20 mg. can be deducted from the results of later experiments.

Before we discuss the effect peculiar to variously located punctures, attention must be directed to certain facts seen in figure 14, depicting

the course of some typical three-stage operations in which the exposure, the puncture and the suturin ; of the wound were separated by intervals of about seven hours.

Figure 14 reveals that there is no difference between operations with or without ethyl carbonate narcosis, and that this drug does not interfere with the result of the experiment (R U 54). Furthermore, this figure, compared with a piqûre operation in one stage, or even in two stages separated by a short interval, illustrates perfectly the additive effect of the various procedures of an operation. It is indeed surprising

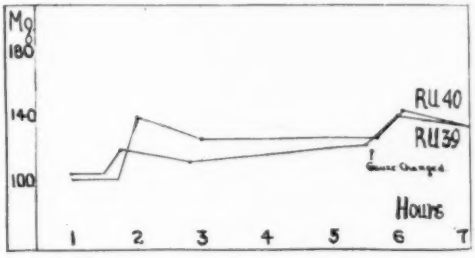

Fig. 11.—The effect of irritation of the wound by the change of gauze, with the animals under ethyl carbonate anesthesia.

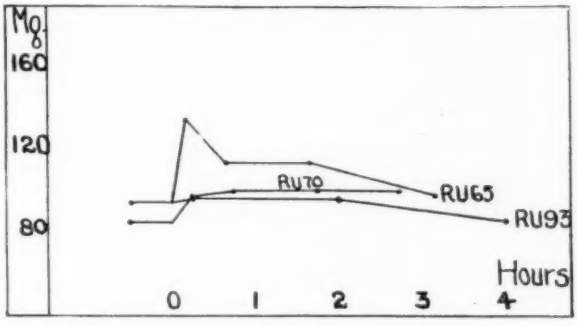

Fig. 12.—The same as figure 11, except that hemorrhage occurred when the gauze was removed. No anesthesia was used. Exposure was made twelve hours before.

to see how slight the effect of the piqûre itself is, at least in two rabbits, in comparison with the accompanying operations. Yet there was a clear unilateral destruction (level XXXV, as shown in the Winkler-Potter Atlas) in R U 56, and a more extensive one destroying the dorsal vagus nucleus of one side in XXXIV and XXXV (W-P) and reaching deeply into the formatio reticularis in R U 57. More clearly than the figures already shown, these curves illustrate the factor of individual excitability which is an important factor in determining the hyperglycemia after the puncture as well as after the other procedures. Finally, these curves

prove that the surprisingly low rise of the blood sugar after the puncture itself cannot be due to exhaustion of the animals. Apart from the fact that all the rabbits were in good condition before the puncture, the high rises of the blood sugar after a third operation prove their ability to respond to stimulations.

To exclude as many sources of error as possible, and knowing from experience the negligible effect of a little excitement on the occasion of the piqûre under careful conditions, we decided to operate on all the following rabbits without ethyl carbonate. The results of sugar punctures obtained in two-stage operations after the floor of the fourth

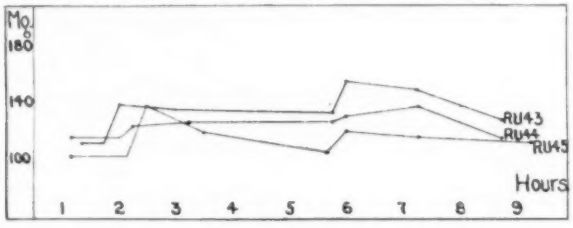

Fig. 13.—The effect of posture with minimal irritation, as gauze was not packed into the wound.

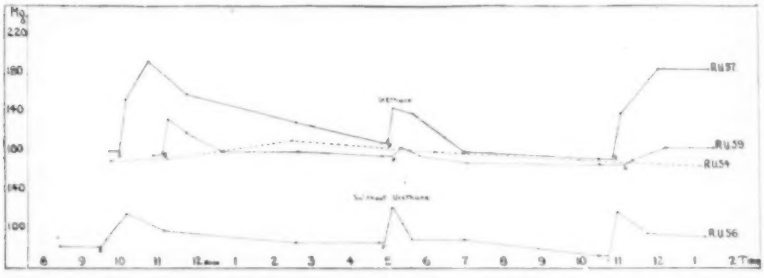

Fig. 14.—The effect of three-stage operations; *E*, exposure; *P*, puncture, and *S*, suturing of the wound.

ventricle had been exposed about twelve hours previously, may be grouped according to the location of the punctures within the confines of different nuclei of the medulla.

The Dorsal Vagus Nucleus.—It is the general belief, and especially the assertion of Brugsch, Dresel and Lewy, that the dorsal vagus nucleus is the site of the "sugar center" in the medulla oblongata. Included in our punctures there are eighteen in which the dorsal vagus nucleus was the only, or at least the most conspicuously, damaged region on one or both sides. In some cases the twelfth nucleus or the formatio reticularis was involved in the lesion. Microscopic examination of serial sections revealed that there was no region of the whole tenth dorsal nucleus left

undamaged. Our observations are surprisingly consistent, showing that wherever we damaged the tenth nucleus the effect remained within a narrow range, and all experiments in this group showed an average rise of the blood sugar of not more than 43 mg., the lowest being 25 mg. and the highest, 64 mg. In figure 15 are the sugar values of six piqûres in which the location of the tenth lesion is given according to the illustrations of this region in the Winkler-Potter atlas.

There is no essential difference between the results of the punctures in any part of the dorsal vagus nucleus either unilateral or bilateral. There is nothing to support the view that a given area of the tenth nucleus has a particular effect on the regulation of the blood sugar, much less that it has the function of a center to increase or decrease the blood sugar.

The Eighth Nucleus.—With the intention of puncturing the tenth nucleus, in a few rabbits we damaged not only the tenth nucleus but the region of the eighth nucleus, and were surprised to find in these punc-

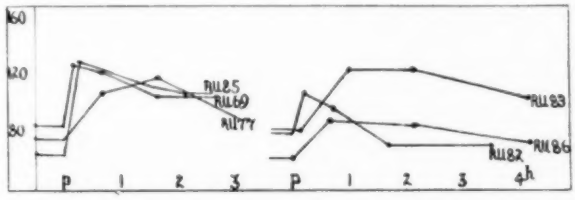

Fig. 15.—The effect of punctures of the dorsal vagus nucleus: RU 69 and RU 77, caudad portion (W-P, XXVI); RU 85, bilateral destruction at level XXVI and unilateral at level XXXV; RU 83 and RU 86, destruction of levels from XXXII to XXXVI bilaterally and unilaterally, respectively; RU 82, complete lesion in levels from XXXIII to XXXV and only in lateral third of XXXVI.

tures a higher hyperglycemia. This was followed by intentional punctures of the eighth nucleus. There were seven combined punctures of the tenth and eighth nuclei, the extent of destruction usually not surpassing those of the lesions of the tenth nucleus only. The rise of the blood sugar in these experiments varied from 60 to 161 mg. According to our previous observations, lesions of the tenth nucleus alone could not account for such a high rise. R U 91, in figure 16, illustrates one of those hyperglycemias in a lesion of the eighth and the tenth nuclei. It may be said that the lesion with regard to its extent and the participation of the tenth in the levels XXXV and XXXVI (W-P) did not exceed the lesion in RU 85, shown in figure 15. Yet a rise of the blood sugar of 158 mg. in RU 91 contrasts with one of 64 mg. in R U 85.

In six other rabbits we succeeded in producing circumscribed lesions in the eighth region only (cross-sections, levels XXIX and XXXIV

[W-P]). The average of the rises in blood sugar amounted to about 90 mg. R U 90 and R U 121, in figure 16, serve as examples of these observations.

When we tried to analyze this whole group of increases of blood sugar from about 60 to 161 mg., our attention was attracted by the observation that it was not the extent of the lesion that seemed to be the most important factor, but rather its location. The further lateral the lesion was located and the closer it came to the region of Deiters' nucleus, the higher the blood sugar rose. Thus when the lesions were produced in the cerebellar part of the eighth system, that is to say, in the region of the nucleus of Bechterew and those fibers traveling from the vestibular region to the cerebellar nuclei, the average rise of the blood sugar became even higher. R U 96 and R U 126 are two of the five rabbits (R U 96,

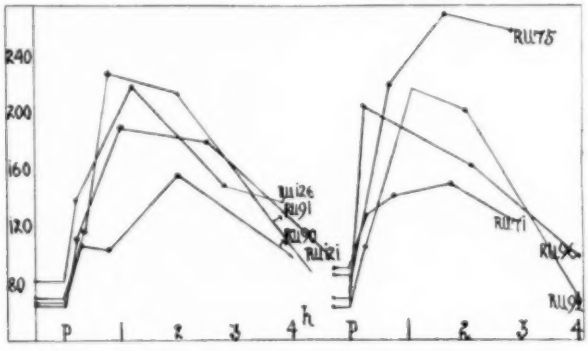

Fig. 16.—Punctures of the eighth nucleus and cerebellum, showing a higher glycemia than punctures of the tenth nucleus.

122, 123, 126 and 127) which showed such lesions and rises in blood sugar of 140, 101, 79, 135 and 101 mg.

The Cerebellum.—The differences in the hyperglycemia produced by lesions of the tenth nucleus and those of the eighth are indeed so conspicuous that we had to conclude that lesions of the eighth region, especially of the vestibular part, which also produced nystagmus and disturbance of equilibrium, were by far more important for the piqûre effect than the lesions of the tenth region. Two experimental procedures were used to support this conclusion: (1) lesions of the cerebellum alone without an eighth nuclear lesion might corroborate our observations; (2) a vestibular irritation other than by central lesions might give more information.

It is known, since the work of Eckhard, that cerebellar lesions can produce a piqûre effect. The work of T. Shinosaki[9] led him

9. Shinosaki, T.: Ztschr. f. d. ges. Neurol. u. Psychiat. **100**:564, 1926.

to conclude that a traumatic lesion of the uvula of the cerebellum produces a high hyperglycemia because of an irritation of afferent fibers arising in the lower portion of the spinal cord, passing through the cerebellum and the brachia conjunctiva and terminating in the subthalamic region.

We performed seven punctures of the cerebellum only, three of which are shown in figure 16 (R U 71, 75 and 92). The average rise in blood sugar was 93 mg., about the same as in the lesion of the eighth nucleus. The clinical symptoms in these rabbits were much like those with vestibular nuclear lesions. Our histologic controls do not warrant a confirmation of Shinosaki's opinion. There is no reason to assume that a lesion of the uvula produces higher hyperglycemia than a lesion of the lobus medianus, much less such a specific effect as Shinosaki concludes from his inadequate experiments. We saw a high rise of the blood sugar after a lobus medianus lesion alone (R U 92) and a high hyperglycemia after a uvular lesion in RU 75, but also four lower ones in R U 71, 89, 94 and 95, averaging about 70 mg. We are inclined to identify the effect of the cerebellar lesions with that of the eighth nucleus. The conformity of the clinical picture and of the blood sugar reaction in both supports the idea of the rôle that excitation of the vestibular system might play in the successful puncture of the fourth ventricle. The conception of a disturbance of the equilibrium of the animal as the inherent physiologic mechanism in the effect of a cerebellar lesion on blood sugar seems to us much more satisfactory than the assumption of an irritation of visceral fibers of doubtful origin and even more doubtful destination. Variations in the degree of response of the blood sugar to cerebellar lesions are probably due much less to the site of the lesion than to the individual characteristics of different animals, as already shown in the first part of this paper.

The Labyrinth.—To prove the importance of vestibular stimuli affecting the sugar level of the blood we finally tried to affect the labyrinth itself. For this purpose we first produced a transient nystagmus and dizziness in rabbits by turning them in a cage at 80 revolutions per minute for five minutes. One rabbit, rotated for thirty minutes, showed only a slightly greater effect. The blood sugar rose 58 mg., in two others (R U 100 and 101) 53 and 51 mg. To produce a more lasting effect we decided to destroy one labyrinth. Here, as in the previous operations, we made use of the two-stage procedure to avoid the hyperglycemic effect of an irritating operation. We exposed the bulla about twelve hours before and kept it easily approachable by means of moistened gauze. The blood sugar was normal the next morning and the animal in perfect condition. The influence of bone destruction which was unavoidable in destroying the labyrinth by breaking the median wall of the bulla, was ruled out by puncture in an indifferent place by a blunt

probe. The effect of such procedure is shown in R U 103 and in the left half of the curve of R U 109 in figure 17. The rise in the blood sugar varied between 7 and 16 mg., reaching 24 mg. in only one of the other rabbits operated on in such a way.

The destruction of the labyrinth was followed by the typical clinical picture of such an operation and led to a hyperglycemia of 75 and 66 mg., as seen in R U 113 and R U 109 (right half) in figure 17.

The procedure given warrants the assumption that a peripheral vestibular disturbance also has a marked effect on the blood sugar. It may be added that in these last experiments, as well as in the previous ones dealing with irritation of the vestibular system, hyperactivity of the animals, as for example rolling movements, proved not to be the essential factors of the hyperglycemia. Identical rises of the blood sugar often appeared when such hyperactivity was missing or could be checked successfully.

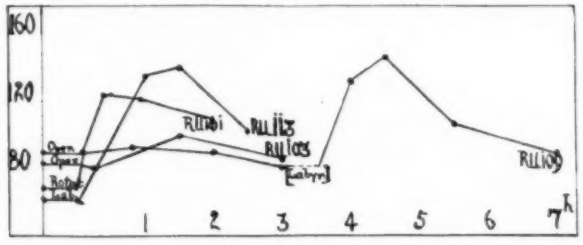

Fig. 17.—The effect of labyrinthine irritation and destruction.

SUMMARY

It has been shown that previous work in influencing the blood sugar by means of a "sugar puncture," from the time of Claude Bernard, failed to prove the essential importance of this part of the central nervous system as a so-called sugar center. Previous experiments were bound to fail because they neglected to take into consideration a number of irritating influences on the blood sugar. These factors are plainly demonstrated by our experiments. They are: (1) the effect of ether, acting not by means of irritation, but by its own pharmacologic influence either on the central nervous system or on the organs themselves involved in the sugar metabolism; (2) the effect of irritation, which can be at least partly overcome by small amounts of ethyl carbonate which does not produce a steady increase of the blood sugar but merely raises somewhat the general blood sugar level; (3) the effect of the strained head-bent position generally used in experiments on rabbits, an irritating factor even when asphyxia does not result; (4) the effect of any operation, especially the procedures used in connection with the sugar puncture. The only means of avoiding all these noxious influences obscuring the result specific to the sugar puncture itself was to operate on the

animals in what was termed a two-stage operation, using an interval of at least from six to seven hours between the exposure of the fourth ventricle and the puncture itself.

With the application of this new kind of a piqûre, the rôle of different regions, especially of nuclei in the medulla oblongata, was established in their relationship to hyperglycemia.

It was proved that the dorsal vagus nucleus, which is still considered the site of the sugar center in the recent work of Brugsch, Dresel and Lewy, has no more to do with the regulation of the blood sugar than any other part of the nervous system, the irritation of which leads to a moderate hyperglycemia. It was shown that the irritation of the vestibular system, especially the region of the nuclei of Deiters and Bechterew and their fiber connections with the cerebellum, of the cerebellum itself, and also of the labyrinth, leads to a considerably higher rise of the blood sugar than other lesions of the medulla oblongata.

We do not believe that this response of a vestibular irritation is essential to the function of this apparatus. It shows merely that stimulation of afferent fibers leads to hyperglycemia. Whether these are pain fibers stimulated, for instance, in pinching a peripheral nerve, fiber systems conducting impulses for the regulation of equilibrium, or specific sensory fibers, is not of fundamental importance.

It seems likely to us that a control of the so-called water, salt and allantoin punctures on the basis of this modified type of a piqûre, with the utilization of the experiences obtained in our present work, will lead to similar results.

The fact that cerebellar lesions have a positive effect speaks against an irritation of afferent sympathetic fibers which, according to present knowledge, do not travel through the cerebellum. The other fact that the effect of medullary lesions is not as much dependent on the extent and the depth of a lesion as on its lateral location is at least not in favor of an irritation of centrifugal sympathetic fibers, which probably run in a deeper layer, as Karplus and Kreidl [10] assumed.

Thus we believe that a sugar puncture of the floor of the fourth ventricle exerts its effect not through stimulation of sympathetic fibers, but through afferent fibers. At present, the regulation of blood sugar cannot be ascribed to definite centers but we have proved that hyperglycemia is produced through afferent stimuli of widely varying nature.

ABSTRACT OF DISCUSSION

Dr. Loyal Davis: My colleagues and I have made experiments on animals in which we attempted to influence the amount of sugar in the blood and spinal fluid by stimulation of the cervical sympathetic trunk. The ether anesthesia alone

10. Karplus and Kreidl: Pflüger's Arch. f. d. ges. Physiol. **129**:138, 1909; ibid. **135**:401, 1910; ibid. **143**:109, 1912.

in cats produced the same rise that was shown tonight. The experimental work reported here has been well controlled and well carried through.

Dr. Ralph Hamill: It would seem difficult to eliminate the effect of emotion in these animals, even though they were under an anesthetic.

Dr. Hiller: That irritation may lead to a rise in blood sugar content was a point that we had to exclude, and the curves shown proved that even hemorrhage caused by taking out the gauze from the fourth ventricle does not produce a higher rise than 20 per cent. Then, if emotion affected the results it would not be understandable why the rise was three times as high in cerebellar punctures as in puncture of the tenth nucleus.

We have tried to think of all the objections that could be made to our experiments, but we feel sure that the tenth dorsal nucleus has nothing to do as a center with the regulation of the blood sugar.

If one reads the articles of Claude Bernard and others, he always finds that the authors state that they have punctured the tenth nucleus. No one except Lewy has ever tried to check up the piqûre by anatomic control. From our results, the vestibular region is much more effective than the puncture of the tenth nucleus.

THE NERVOUS REGULATION OF SUGAR METABOLISM

II. EXPERIMENTAL STUDIES *

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AND

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In a previous communication Hiller and Tannenbaum [1] repeated and amplified the experiments of Claude Bernard, who considered, as a result of his piqûre of the medulla, that a medullary sugar center existed. For the first time they most carefully controlled each factor in the piqûre and concluded finally that an irritation of the dorsal vagus nucleus as a hypothetic center for sugar metabolism did not lead to an increase in blood sugar. Thus the age old conception of a medullary sugar center from physiologic evidence must be abandoned.

In 1920, Brugsch, Dresel and Lewy [2] attacked the problem from another angle in order to obtain verification of their experiments confirming the presence of a sugar center in the medulla. They sought to show anatomically the intimate relationship between the vagus nerve, the sympathetic cervical trunk, the dorsal vagus nucleus and the visceral centers in the 'tween-brain. The purpose of this work has been to verify or disprove their anatomic contentions.

The dorsal vagus nucleus is a bilateral collection of cells lying in the dorsal gray matter of the medulla close beneath the floor of the fourth ventricle. It extends from the lower portion of the vestibular nucleus and the posterior third of the hypoglossal nucleus to slightly caudad to the calamus scriptorius. The nucleus staderini overlies it above, and the fasciculus solitarius borders it laterally. The fibers arising from the dorsal vagal cells comprise most of the vagus nerve; the remainder arise from the nucleus ambiguus. According to Molhant [3] the vagus fibers are of extremely small caliber and myelinate late, but in undergoing secondary degeneration give the Marchi reaction exceptionally early.

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* Submitted for publication, Feb. 27, 1929.

* From the Division of Neurology of the Department of Medicine and the Douglas Smith Fund of the University of Chicago.

* Read at a Meeting of the Chicago Neurological Society, Jan. 17, 1929.

1. Hiller, F., and Tannenbaum, A.: The Nervous Regulation of Sugar Metabolism: I. Experimental Studies, Arch. Neurol. & Psychiat., this issue, p. 901.

2. Brugsch, T.; Dresel, K., and Lewy, F. H.: Zur Stoffweschselneurologie der Medulla oblongata: I, Ztschr. f. exper. Path. u. Therap. **21**:2, 1920.

3. Molhant, M.: Le noyau dorsal du vague, ses connexions anatomiques et sa valeur fonctionnelle, Névraxe **11**:137, 1910.

They do not supply striated muscle and in the visceral sense are presumed to be a medullary "sympathetic area."

Malone [4] has indicated that two types of cells exist in the nucleus, the round plump cells which probably innervate nonstriated structures, and the more elongated cells with a coarser arrangement of Nissl substance which probably innervate heart muscle. According to Molhant, there is a topical arrangement of the nucleus. He considers that almost the entire dorsal vagus nucleus is motor, that is, efferent, in function.

It is well known that the peripheral portions of the autonomic nervous system in its sympathetic and parasympathetic components are intimately in relation to one another. This is especially true of the various thoracic and abdominal ganglia, into which both types of fibers run and are separable with difficulty. But it must not be concluded that because vagal fibers enter a sympathetic ganglion its cells of origin are sympathetic in function, arbitrary though this classification may be.

Molhant, in his studies of the vagus nuclei, found, after destruction of the superior cervical ganglion, that a few cells in the middle portion of the dorsal vagus nucleus showed a retrograde reaction. The presence of these cells and the number of them involved varied in different animals. On the other hand, after cutting the vagus nerve below the superior laryngeal branch the cells of the vagus nucleus were in a state of primary irritation except for a few cells in the middle portion apparently corresponding to those cells which reacted after the superior cervical ganglion was destroyed. Molhant explains these observations by the assumption that high in the neck the vagus nerve, below the jugular ganglion, sends a few communicating fibers to the superior cervical ganglion.

Brugsch, Dresel and Lewy utilized these data to interpret their experimental sugar puncture. They assumed that the vagal fibers communicating between the jugular and superior cervical ganglia are truly sympathetic in nature although their final destination is not known, and furthermore, that the dorsal vagus nucleus is a mixed sympathetic and parasympathetic center. Thus they found, after puncture of the anterior part of the nucleus, hypoglycemia which they concluded results from parasympathetic irritation by way of the vagus to the pancreas, and, after puncture of the posterior part of the nucleus, hyperglycemia because of sympathetic irritation, by way of the suprarenal glands. They [5] found further proof for this belief in that anatomic studies of partially depancreatized dogs revealed a degeneration of the anterior or

4. Malone, E. F.: The Nucleus Cardiacus Nervi Vagi and the Three Distinct Types of Nerve Cells Which Innervate the Three Different Types of Muscles, Am. J. Anat. **15**:121, 1913.

5. Brugsch, I.; Dresel, K., and Lewy, F. H.: Zur Stoffweschselneurologie der Medulla Oblongata: II, Ztschr. f. d. ges. exper. Med. **25**:262, 1921.

parasympathetic part of the dorsal vagus nucleus. These workers further claimed that other sympathetic fibers may arise from the vagus nucleus, descend the cord to the upper dorsal region and find their way to the inferior cervical ganglia.

To check these assertions of Brugsch, Dresel and Lewy, which are at variance with the studies of Hiller and Tannenbaum, studies were

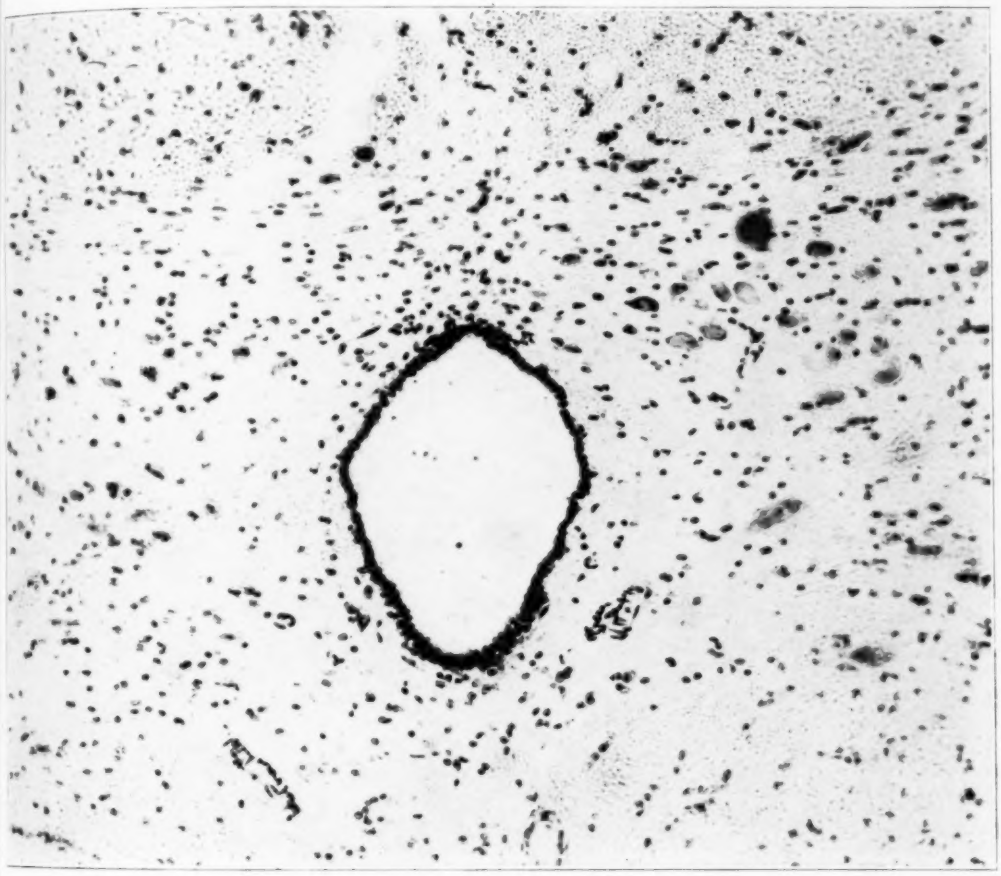

Fig. 1.—Section through the inferior portion of the dorsal vagus nucleus, showing every cell in retrograde reaction after the vagus was cut below the recurrent laryngeal nerve. Toluidine blue; × 400.

made of the dorsal vagus nucleus, the method of axonal reaction or primary irritation being used.

In two rabbits, one vagus nerve was severed below the superior laryngeal nerve. In two rabbits, the nerve was cut far down the neck below the recurrent laryngeal branch in order to avoid cutting any fibers perhaps destined for the sympathetic trunk. To perform such an opera-

tion the animals were given artificial pneumothorax daily, three days beforehand, as otherwise the sudden operative pneumothorax easily killed the animal. The rabbits were kept alive for ten days and killed with ether anesthesia; the medullas were cut serially in celloidin and stained with toluidine blue.

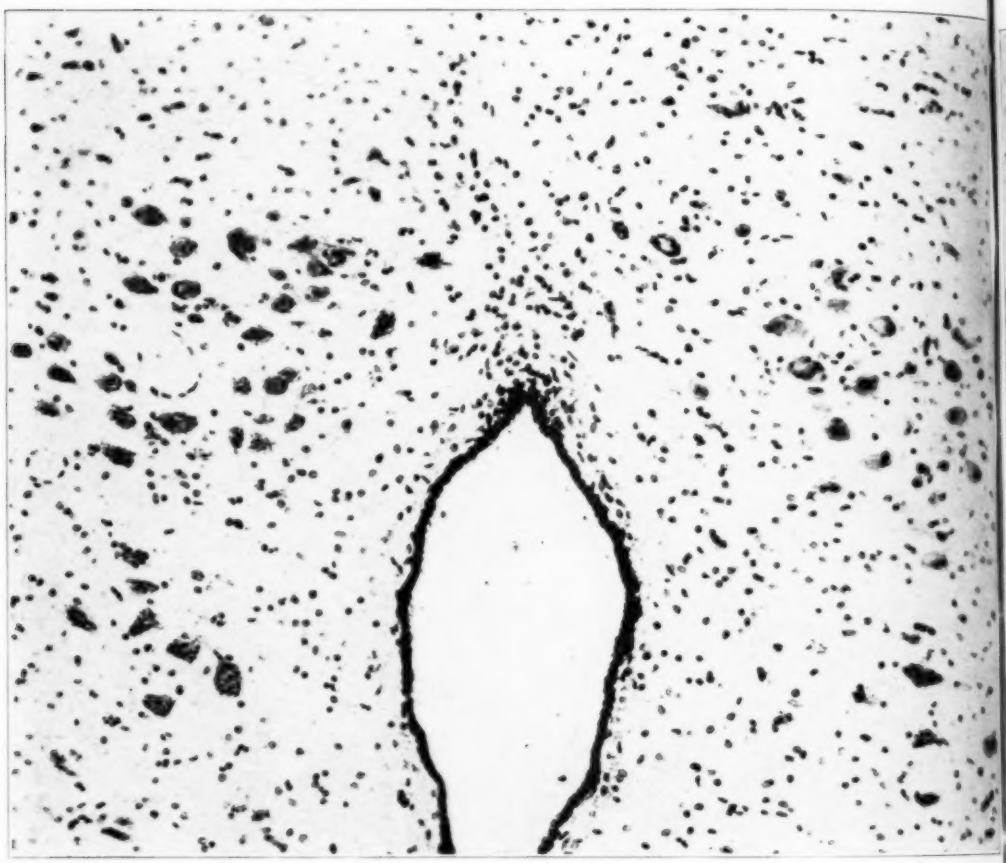

Fig. 2.—Section of the middle portion of the dorsal vagus nucleus of the same animal as in figure 1. Toluidine blue; × 400.

Study of these sections revealed a most complete primary irritation of practically all of the cells of the dorsal vagus nucleus at all levels. Figures 1, 2 and 3 show that an exceptional cell may not become as swollen or as chromatolyzed as the others, but that it is distinctly in a primary irritation. Almost the entire nucleus was in primary irritation even in those animals in which the vagus was cut below the recurrens nerve. No definite cell group or portion of the nucleus was spared; in

fact, the cells of the more posterior portion seemed to be swollen the most. No reaction was found on the contralateral side.

In three rabbits, the sympathetic trunk was cut on one side; examination of the vagus nucleus revealed no irritated cells. From these two procedures it may be stated that the vagus nucleus gives off fibers destined almost entirely for the vagus nerve, and that if any fibers join

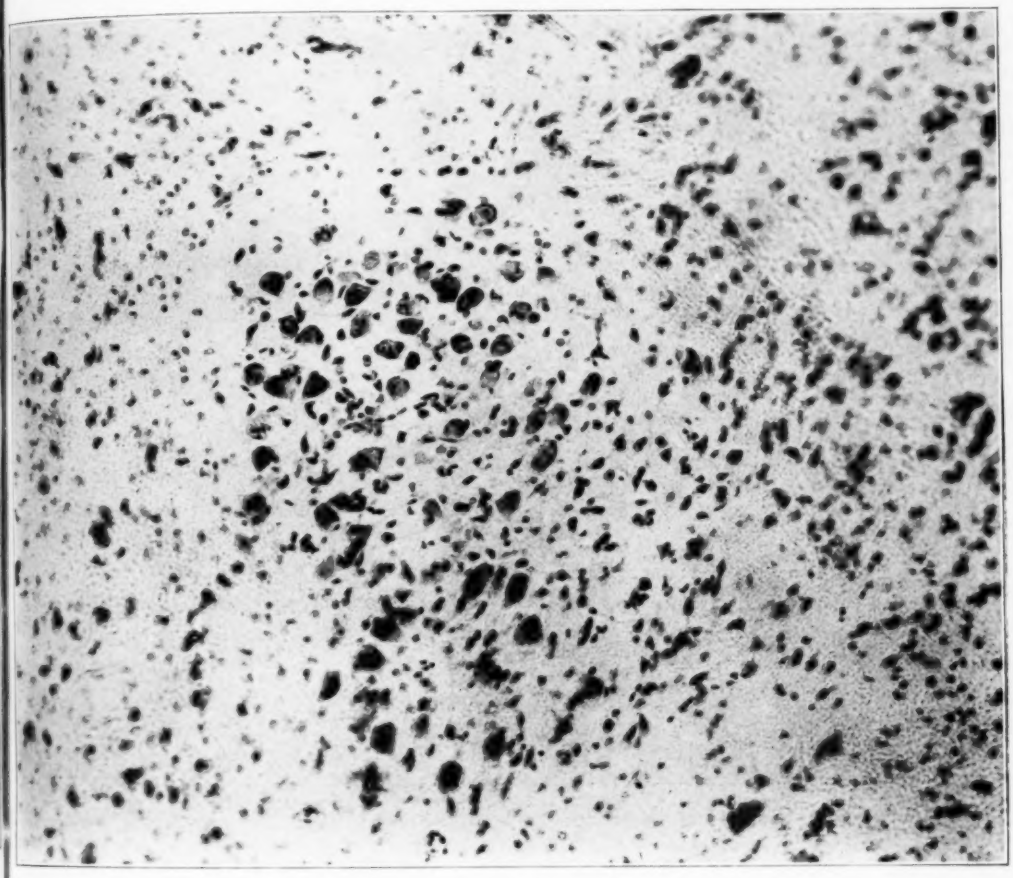

Fig. 3.—Section of the upper portion of the dorsal vagus nucleus of the same animal as in figure 1. Toluidine blue; × 550.

the sympathetic trunk they must be few and unimportant and not constant in all animals.

To be sure that no vagal fibers descend the cord and thus join the sympathetic nerve, a transection was made in two rabbits at the level between the seventh and eighth cervical segments. Again no retrograde reaction was found in the dorsal vagus nucleus, precluding the possibility of any long descending intramedullary vagal fibers.

It is generally considered that the diencephalon contains areas which have a regulatory influence on vegetative functions, including those of fat, salt, water and sugar metabolism. The relation of these hypothalamic centers and more caudad subordinate centers for metabolic regulation is still hypothetic. As far as sugar metabolism goes, Hiller and Tannenbaum have demonstrated that no such medullary center exists. Thus, little is known of how the influence of the 'tween-brain is mediated peripherally.

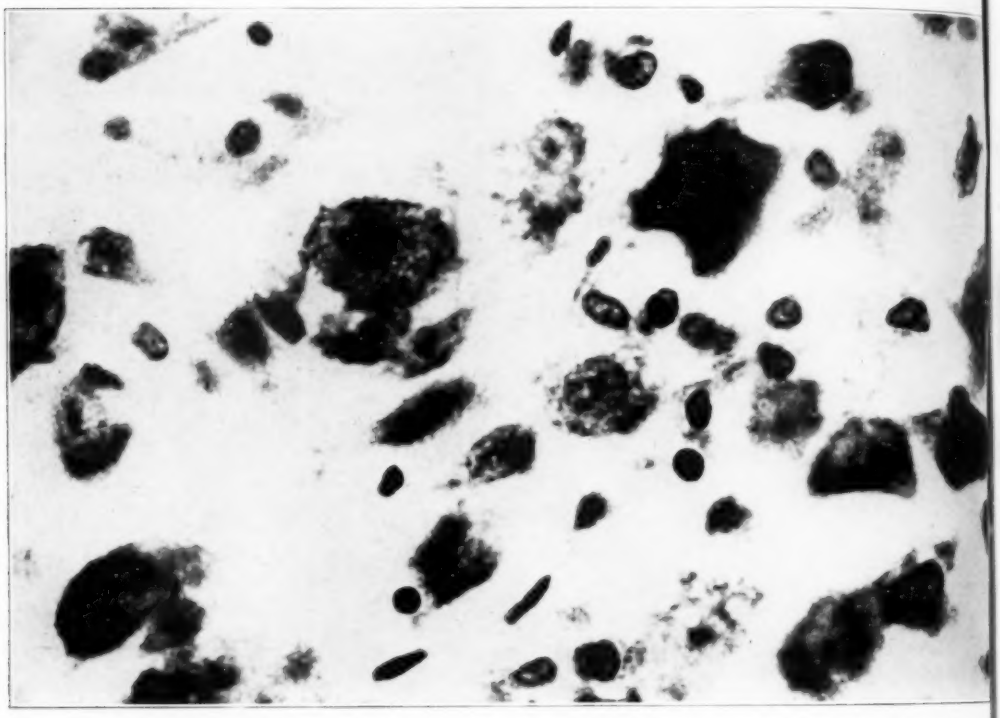

Fig. 4.—Cells from the nucleus paraventricularis of Malone of a normal rabbit, showing the close resemblance to pathologic cells. Toluidine blue; × 750.

Brugsch, Dresel and Lewy, however, believed that the diencephalon is directly superimposed on the hypothetic medullary centers. They quoted the work of Huet,[6] in 1898, who destroyed the superior cervical ganglion and found a diffuse cell disappearance in a sickle-shaped area on the floor of the third ventricle in the homolateral ganglion habenula and to a lesser degree in the contralateral ganglion. This could take

6. Huet, W. G.: Zwischenhirn und Halssympatheticus, Pflüger's Arch. f. d. ges. Physiol. **137**:627, 1910.

place, of course, only if a single uninterrupted neuron arose from the 'tween-brain, descended the medulla and traveled out by way of the vagus nerve.

These workers studied the diencephalon in animals with extensive destruction of the dorsal vagus nucleus made by a piqûre and found a loss of cells in the nucleus paraventricularis and of the ganglion habenula. It is obvious that a section of the hypothalamus made somewhat obliquely may give an asymmetric appearance to the section and simulate a falling out of cells. In the illustration of the 'tween-brain lesion given by Brugsch, Dresel and Lewy, such was the case as evidenced by the unequal height of the columns of the fornix. Furthermore, pathologic changes in the central gray matter are difficult to determine owing to the peculiar normal structure of the cells which are round and vacuolated as shown by Malone (fig. 4).[7] This criticism has been previously leveled at the same workers who concluded, on the basis of studies made on brains of diabetic persons, that the globus pallidus was a center for sugar metabolism superimposed on the hypothalamus. They found degenerative-like cells with marked satellitosis, which is typically normal for the pallidal cells.

To repeat this work, serial sections were made of the diencephalon in rabbits after one vagus nerve had been cut; no changes were found. Next, three rabbits in which an almost total destruction of the dorsal vagus nucleus had occurred were examined ten days later, and a perfectly normal diencephalon was found in both.

Finally, to prove conclusively that no direct communication exists between the hypothalamus and the dorsal vagus nucleus to the sympathetic trunk or to any other medullary region, a hemisection of the medulla was performed in two rabbits above the vagus nucleus. The animals were kept alive for seven days. The diencephalon in each was found to be normal. Neither the ganglion habenulae nor the nucleus paraventricularis was changed. If any efferent connection exists from the 'tween-brain and the medulla, it is not by a single neuron but by several intercalated cells. This cannot be shown by the method of primary irritation.

Thus, from the evidence and the preceding paper of this series, it has been shown that the dorsal vagus nucleus is a collection of purely vagus cells and is not directly subordinate to the hypothalamus, nor is it a medullary sugar center.

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7. Malone, E. F.: The Nuclei Tuberis Laterales and the So-Called Ganglion Opticum Basale, Johns Hopkins Hosp. Rep., New Series, 1914, vol. 6.

THE HISTOLOGY OF NEUROGLIAL CHANGES FOLLOWING CEREBRAL TRAUMA

AN EXPERIMENTAL INVESTIGATION *

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Knowledge of the histology of the elements which go to form the connective tissue of the nervous system has been advanced in recent years principally owing to the labors of Ramon y Cajal and his followers in the institute of his name at Madrid.

By the perfection of various histologic methods of impregnation of nerve tissue by gold and silver salts it is now possible to distinguish four different types of cells which make up the neuroglial or supporting tissue of the nervous system. Macroglia is the term applied to two of these types, which are large cells having processes radiating from a central cell body. On account of their general form the macroglia cells are now known as astrocytes, and the two types vary principally in the presence or absence of fibrils in their protoplasm, thence arising the terms fibrillary and protoplasmic astrocytes.

The remaining two types of connective tissue cells in the nervous system have been known under the general term of the "third element" of Cajal. By modern staining methods this "third element" is capable of being divided into two distinct types of cell, the oligodendroglia cell and the microglia cell.

If it is taken for granted that the main, if not the sole, function of neuroglia is the support of the neural elements, it seems unnecessary that four distinctive types of cells should be developed in the same tissue for the same purpose. It is possible, however, that these cells have subsidiary functions and that these secondary functions may differ according to the type of cell.

The work, of which this article is the report, was undertaken primarily to repeat the work of Penfield [1] on neuroglial reaction to brain injury, as simple aseptic trauma of the brain seemed to open up possibilities of bringing to light different functions for the various types of neuroglia cell.

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* Submitted for publication, Aug. 31, 1928.

* From the Anatomy Department, University of Toronto.

1. Penfield, W.: The Mechanism of Cicatricial Contraction in the Brain, Brain **50**:499, 1927. Penfield, W., and Buckley, R. C.: Punctures of the Brain: The Factors Concerned in Gliosis and Cicatricial Contraction, Arch. Neurol. & Psychiat. **20**:1 (July) 1928.

TECHNIC

A series of ten rabbits was used for this research. After ether anesthetization, holes were made in the skull overlying the cerebral hemispheres. A small burr driven by an ordinary dental engine was employed for this purpose. Points were chosen about midway in the anteroposterior length of the hemisphere, in order to avoid the visual disturbances produced by a lesion too far toward the occipital pole and a motor paralysis consequent on a lesion made too far forward. Through the burrhole over the right hemisphere the brain was wounded by the insertion of an ordinary blunt probe for from 1 to 3 cm. into the brain tissue. On the left side a glass tube, sharpened at the end and drawn out to a sufficiently fine caliber to pass through the burr hole, was pushed into the brain for a distance of from 1 to 3 cm. By this means, the damaged brain tissue was left in situ in the wound of the right hemisphere, whereas on the left it was removed as a core in the lumen of the glass tube. This was done because Penfield claimed that much less reaction occurs if the damaged brain tissue is removed than if it is left in position; we sought confirmatory evidence for this important statement, far-reaching in its clinical bearing.

The wound was sutured, and different rabbits of the series were killed at periods varying from three days to two months after the date of the brain wound. These comparatively short periods were chosen because considerable attention has been paid to the neuroglial reaction in wounds for longer periods, and it seemed valuable to consider the more immediate changes which take place around a cerebral trauma; at the same time some rabbits of the series were left for a sufficient time to overlap the periods given in the published results of previous workers. The rabbits were killed with chloroform and the hemispheres were removed. It was interesting to note that during its postoperative life the animal frequently showed little abnormality in behavior. We had only one case in which death could be said to be due to the operation. The animal died within twenty-four hours after the operation, and autopsy showed diffuse subarachnoid and intraventricular hemorrhage. Bailey[2] recently remarked on the dangers of hemorrhage from the use of a sharp needle in clinical cases.

When the skull was removed, it was customary to find that there was less adherence of the membranes to the skull on the side damaged by the hollow needle than on the side which had received the probe wound. It was occasionally observed that on the side of probe injury a core of brain tissue, adherent to the dura under the burr hole, was apt to be removed with the bone. Thus, on the whole, the probe wound was found to give the more definable lesion; this was confirmed on examination of the surface of the hemisphere. It was sometimes extremely difficult, even after as short a period as a fortnight, to be sure with the naked eye of the exact position of the lesion.

Blocks of each hemisphere, with the wound as the center of the block, were removed and transferred to a formaldehyde-bromide fixing solution, a piece of normal brain tissue far distant from the wound being, as a rule, put into the same fixative for section as a control.

In the short period experiments, i. e., those in which the brain had been wounded for two weeks or less, our interests, led by recent work on the subject (Hortega[3]), were principally focused on the possible changes occurring in the

2. Bailey, Percival, in discussion on papers by Penfield and Buckley, Globus and Cone: Arch. Neurol. & Psychiat. **20**:72 (July) 1928.

3. Del Rio-Hortega, P.: La microglia y transformación en células en bastoncito y cuerpos gránulo-adiposos, Trab. d. lab. de invest. biol., Univ. de Madrid, **18**:37, 1921.

microglia and oligodendroglia elements, and consequently such wound blocks, after a short fixation, were cut by frozen sectioning in the longitudinal axis of the wound and were then impregnated by Penfield's modification [4] of the silver carbonate technic of Hortega. The longer period wound blocks were fixed for eleven days in formaldehyde-bromide, cut by the freezing microtome and stained by the gold sublimate impregnation method of Hortega as used by Bailey.[5] This method impregnates the astrocyte or macroglia elements of neuroglia, the changes in which we expected to form the predominant connective tissue reaction in wounds more than a fortnight old.

Frequently, as will be noted later and more particularly in the short-period wounds, one hemisphere was impregnated with silver carbonate and the other with gold sublimate in order to get parallel pictures of microglia and macroglia reactions.

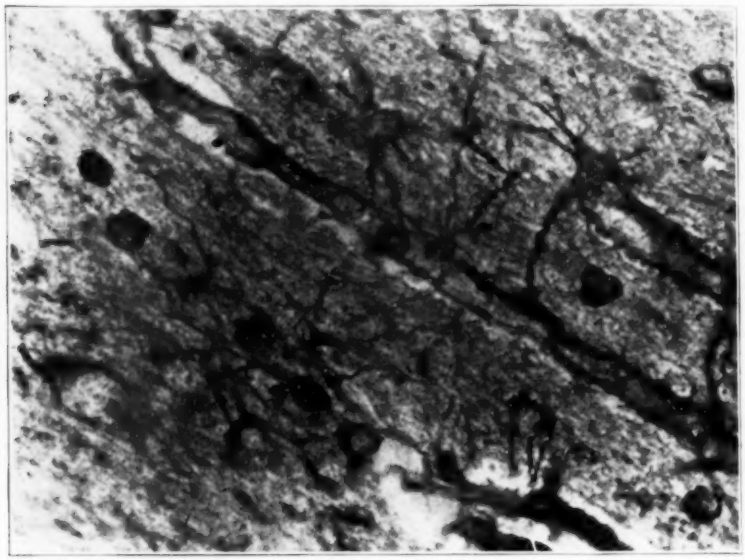

Fig. 1.—High power view of oligodendroglia cells in subcortical white matter. A typical fibrous astrocyte (unimpregnated) with a foot plate on a vessel wall gives the comparative sizes of oligodendroglia and astrocyte.

NORMAL HISTOLOGIC FEATURES OF NEUROGLIA

Before I describe the changes which occur in neuroglia in response to wounds of the brain, it is necessary to consider briefly some points in the normal anatomy of these cells.

Oligodendroglia.—This cell type can be dismissed in a few words as, from the point of view of this article, it is unimportant. Most observers are agreed that the oligodendroglia cell plays a purely passive part in the neuroglial changes due to cerebral trauma. Figure 1 shows a high power view of the white matter

4. Penfield, W.: Oligodendroglia and Its Relation to Classical Neuroglia, Brain **47**:430, 1924.

5. Bailey, P., and Hiller, G.: The Interstitial Tissues of the Nervous System: A Review, J. Nerv. & Ment. Dis. **59**:337 (April) 1924.

of the rabbit's hemisphere impregnated with silver carbonate to show oligodendroglia. The cell body is seen to have a central clear nucleus surrounded by a ring of cytoplasm which takes the silver carbonate strongly. I have found extreme difficulty in impregnating successfully the processes of these cells, as they have been described by other observers.

These cells are found almost exclusively in white matter, and their nuclei are seen in ordinary histologic preparations lying in rows between the nerve fibers. They do, however, extend to a limited degree into the deeper layers of the cerebral cortex.

Microglia.—These, as their name implies, are the smallest of the neuroglia elements. The high power photomicrograph (fig. 2) indicates their general features. The small nucleus is often completely impregnated but the more lightly stained cells show the centrally placed nucleus to be clear. The multiple short

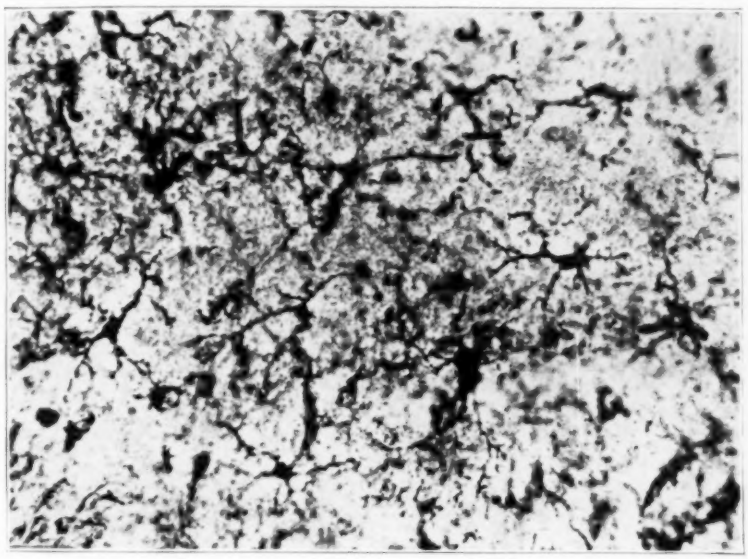

Fig. 2.—High power photograph of microglia to show the general arrangement.

processes with their spiny secondary branches are distinctive features. Figure 3 gives more detail of the structure of the microglia elements as seen through an oil-immersion lens. In the gray matter, microglia cells show a marked tendency to perineuronal satellitosis, and throughout the nerve tissue, but more particularly in the white matter, they are found lying in a similar intimate relationship with blood vessels.

These cells seem to be scattered fairly uniformly throughout the whole nerve tissue and are believed by most authorities (Bailey and Cushing,[6] Penfield[7]) to be

6. Bailey, P., and Cushing, H.: Tumours of the Glioma Group, Philadelphia, J. B. Lippincott Company, 1926.

7. Penfield, W.: Microglia and the Process of Phagocytosis in Gliomas, Am. J. Path. **1**:77, 1925.

mesodermal in origin and to have broken into and proliferated in the central nervous system at an early stage in development.

Astrocytes.—The two types of astrocyte, known collectively as macroglia or classic neuroglia, are so similar in general features as to be describable under one heading. The protoplasmic astrocyte shows a large cell body, with a large nucleus variously disposed in the cytoplasm. The cytoplasm impregnates deeply with the gold sublimate impregnation method of Hortega. The processes of the cell are multiple, show well marked racemose branching and tend to be wavy in their contour. Figure 4 is an oil-immersion view of such an astrocyte.

These cells inhabit the deeper layers of the cerebral cortex and are found in their most typical form in deep lying gray masses such as the basal ganglia. The protoplasmic astrocyte is believed to be capable of transformation into a fibrillary astrocyte by the development within its cell body and processes of darkly staining

Fig. 3.—"Round" nucleated type of microglia cell with multiple branching processes. Oil-immersion.

fibrils. It is reasonable to assume that the acquisition of intracellular fibrils increases the functional efficiency of the cell as a "binding" structure and this gains support from the anatomic observation that the protoplasmic astrocytes are found in those positions in the nerve tissue in which strain may be considered to be normally at a minimum. In conditions of cerebral trauma, such as will shortly be considered, in which it is justifiable to think that "strain" within the nerve tissue is increased, the astrocytes forming the reaction are solely those which have developed well marked intracellular fibrils.

These protoplasmic astrocytes have well marked "sucker-feet" or processes of attachment to the walls of blood vessels. They show no tendency to perineuronal or perivascular satellitosis. For optimum impregnation the period of fixation is somewhat shorter than that for satisfactory impregnation of the fibrous astrocytes, and histogenetically they probably represent a slightly more primitive type of cell.

The fibrous astrocyte differs from the protoplasmic type in that the cell body has a multi-angular shape. The cytoplasm stains lightly in comparison with the heavy impregnation of the fibrils which it contains. The large round nucleus often gives the appearance of being placed adventitiously at the junction point of the crossing of a great number of fibers, resembling an egg lying on a bundle of crossed twigs. The processes which arise from the angles of the cell are little more than fibrils covered by a tenuous coating of protoplasm; they are straight and show much less tendency to branching than do those of the protoplasmic astrocyte.

Fig. 4.—An oil-immersion view of a protoplasmic astrocyte from the basal ganglia. Note the wavy branching processes.

Fibrous astrocytes are found principally, under normal conditions, in the superficial layers of the cerebral cortex and throughout the whole extent of the white matter of the central nervous system.

Figure 5 is a low power view of the normal arrangement of fibrous astrocytes in the white matter of the cerebral hemisphere of the rabbit. Toward the center of the field will be seen two cells, each with a long straight process attached to the wall of a blood vessel by a "sucker-foot" or podic process.

As there seems to be some confusion in the literature concerning the exact point of termination of the sucker-foot with reference to its relation to the perivascular space of His, figure 6 was taken to demonstrate that these processes

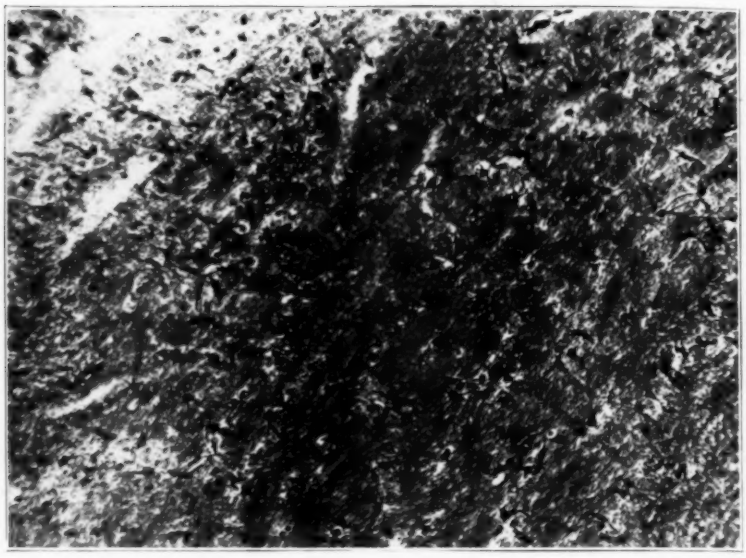

Fig. 5.—Low power view, showing the general arrangement and numerical content of fibrous astrocytes in the white matter of the cerebral hemisphere. Above and to the right of the center of the field two cells show processes of attachment to a vessel wall.

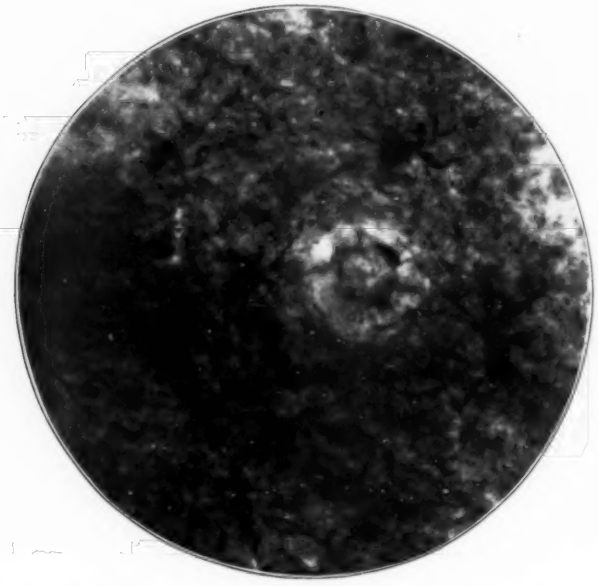

Fig. 6.—High power view to demonstrate the incorporation of the foot-plate with the vessel wall, and passage of its process through the perivascular space to reach its parent cell.

traverse the space of His, and that the "sucker" ending is intimately incorporated with the actual wall of the blood vessel.

The function of the "sucker" processes has been much debated and the name was given under the probably erroneous presumption that they were able to suck nutriment direct from the vessel for utilization by the protoplasm of the whole astrocyte element (Cajal[8]). It is now more generally considered that these processes are in the nature of anchors that give the fibers a stable holding ground from which they can exert their tensile strain. Alzheimer[9] believed that products of nerve metabolism may be transmitted by the astrocytes to the blood stream through these processes. The walls of the small blood vessels in the nerve tissues show multitudes of sucker-feet attached to their outer surfaces (fig. 7). The strain exerted by these attachments seems capable of distorting the vessel lumen. In figure 8 the seven more or less radially attached foot-plates have converted the vascular lumen into a hexagon.

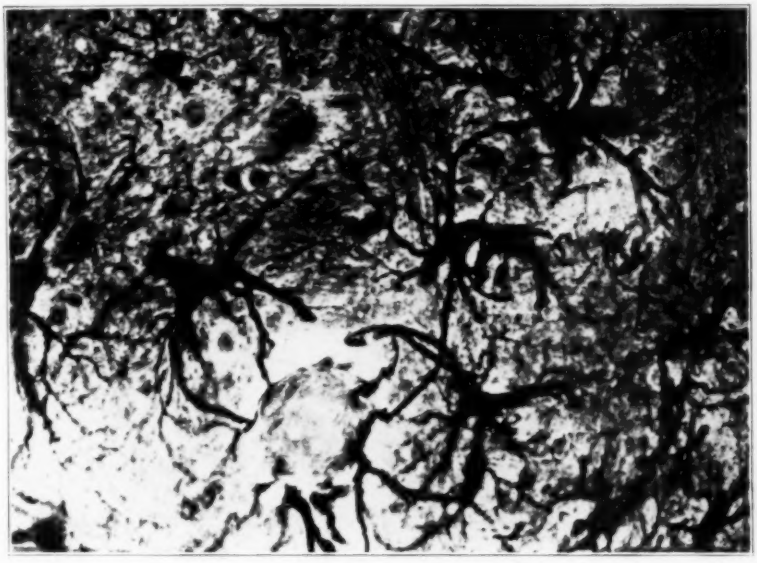

Fig. 7.—High power view of hypertrophied astrocytes to show the attachment of their processes to a vessel wall.

The practical bearing of this fact lies in the impossibility of imagining complete collapse of the small cerebral vessels; this may have an important application in consideration of the phenomena of cerebral edema.

THE REACTION OF THE NEUROGLIA ELEMENTS TO TRAUMATIC CEREBRAL LESIONS

The puncture wounds described under the heading technic initiate a train of histologic changes in the microglia and macroglia cells of the

8. Cajal, Ramon y: L'histologie du système nerveux, Paris, A. Maloine et fils, 1911.

9. Alzheimer, A., quoted by Cone, W.: Acute Pathologic Changes in Neuroglia and in Microglia, Arch. Neurol. & Psychiat. **20**:34 (July) 1928.

nerve tissues. Although reactive signs can be seen in both types of cell as early as the third day following the injury, the function of these changes would appear to be completely different in the two cases. The activity of the microglia reaction is that of scavenging the damaged brain tissue and particularly in removing the myelin of the damaged medullary sheaths. Consequently, this activity reaches a maximum within a comparatively few days after the injury and is far advanced by the time the wound is three weeks old.

Fig. 8.—View similar to figure 7, but showing distortion of the vessel wall to a hexagonal shape by the attachment of seven foot-plates.

The reactive changes in the macroglia or astrocyte cells can also be seen in their inceptive stage in the "youngest" wound examined (three days), but the maximum reaction was found in this series at three weeks and, in wounds examined at longer intervals than this, the astrocytes are seen to play an important and a permanent part in the mechanism of wound repair. The function of the astrocyte reaction seems to be the formation of a firm, protective brain cicatrix.

Three Days.—On examination of a section of the wound area in which the microglia cells have been impregnated by the silver carbonate technic of Hortega, all stages can be seen in the transformation of these cells to "Gitterzellen," compound granular corpuscles or "cuerpos gránulo-adiposos," as they have been termed by various authors. Figures 9, 10 and 11 are taken of such a wound. In figure 9, which shows a field at some distance from the wound track, are seen numerous microglia cells which, although they show changes from the normal (compare with fig. 2), particularly in having less well defined processes, are clearly recognizable as microglia elements. As the wound area is more nearly approached (fig. 10), these cells show a swelling of the

Fig. 9.—Comparatively normal microglia at some distance from a three day wound track; high power.

cell body filled with darkly impregnating granules and a progressive shrinking of the cell processes. Figure 11 shows the most pronounced stage of the microglial reaction of three days' standing, the majority of the cells in this field fitting well into the descriptive term of compound granular corpuscles. Here and there in the larger cells are lighter areas, which are vacuoles of phagocytosed myelin or its degeneration products. In the center of the field, three or four swollen microglia cells will be seen plastered on to the wall of a blood vessel, which is of interest in view of Penfield's [7] statement that these ameboid microglia cells carry their burden of phagocytosed lipoid to the blood vessels and that the lipoid contents of the cells are discharged directly into the blood stream.

Turning to a section of a three day brain wound, in which the astrocytes have been impregnated, examination of the low power photomicrographs (figs. 12 and 13) shows the extent to which the astrocyte reaction has progressed. Figure 12 shows the edge of the wound in the gray matter. Beyond a slight hypertrophy of the astrocyte cell bodies, no particular difference can be seen from the normal arrangement of these cells in the cortex. Figure 13, however, taken close to the track of the wound as it passes through the white matter, shows clearly a

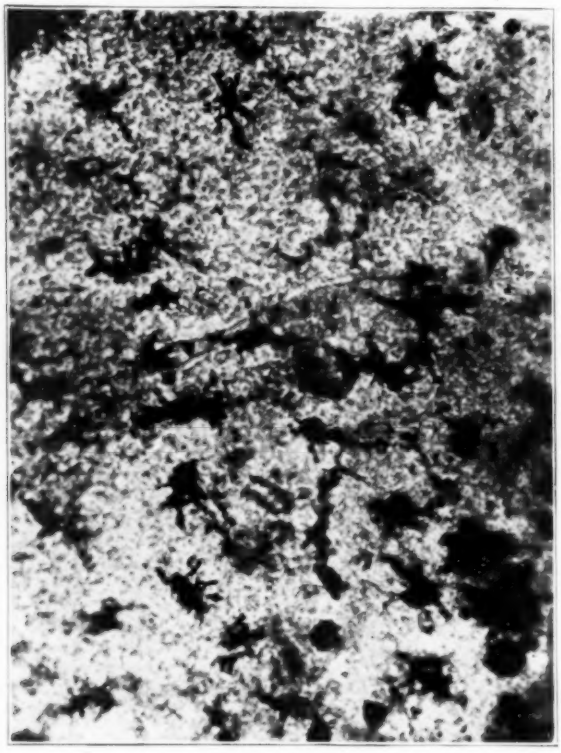

Fig. 10.—Three day wound nearer the track. Note the stages in the transformation to compound granular corpuscles; high power.

hypertrophy of the astrocyte cells when compared with figure 5, which was taken under the same magnification. There is also, even at this early stage, a slight but definite numerical increase of cells toward the region of the wound (fig. 5). The cells in both sections, figures 12 and 13, are uniformly distributed and the only influence of the trauma at this time seems to have been to cause their hypertrophy in situ.

Six Days.—In a postmortem examination performed six days after wounding of the hemisphere, marked progress is seen to have taken

place in the reaction of the microglia cells. These cells in the area of the wound seem to be at the height of their fat-scavenging activity. As a consequence of this the cells become less granular and more adipose; that is, the swollen, protean-shaped cell bodies show a large increase in their fat content in globular form, apparently at the expense of the granules in the cytoplasm. As it is the granules which impregnate with silver carbonate it is more difficult to pick up suitable cells for purposes of photography. It is to be noted that Hortega [3] obtained this stage

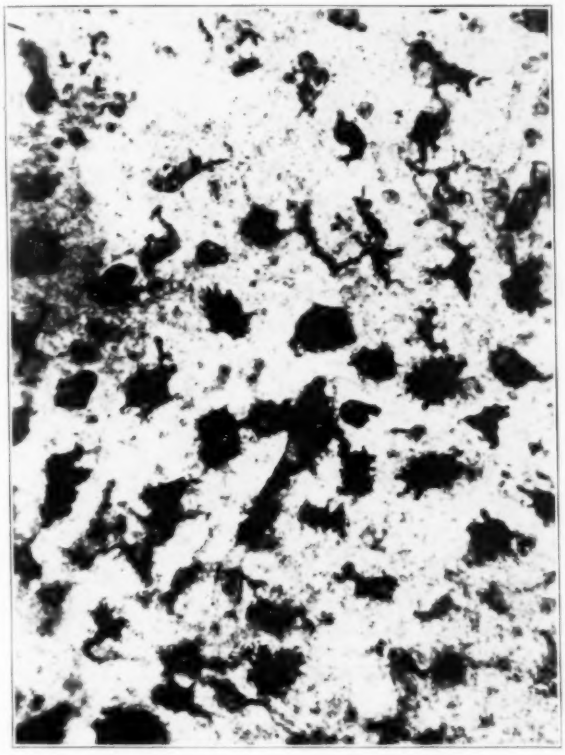

Fig. 11.—Region of wound track at three days. Fully formed compound granular corpuscles. Just below the center of the field a number of these corpuscles will be seen plastered on a vessel wall; high power.

of microglial reaction in his experimental animals after a period of only two days. He used a hot probe as the traumatizing body, and it is possible that this may account in some way for the speeding up of the reaction.

Figure 14 is an oil-immersion view of microglia six days after wounding. The two cells in focus in figure 14 show the tendency

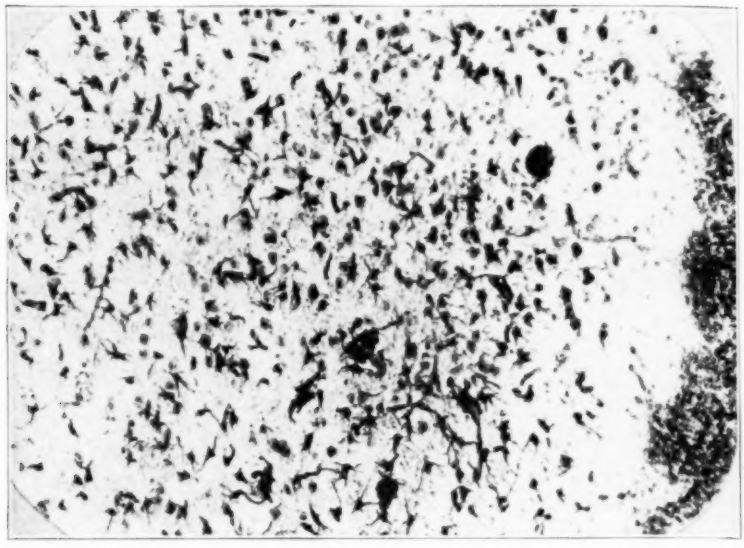

Fig. 12.—Early stage of astrocyte hypertrophy in the gray matter. Three day wound. Track to right; low power.

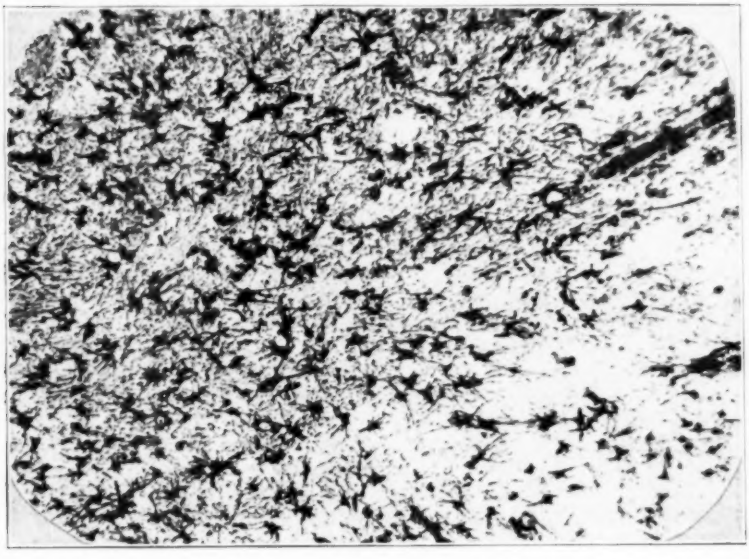

Fig. 13.—Hypertrophying astrocytes in the white matter in the same case as figure 12. Wound track to right; low power.

toward a spherical form and impregnate much less darkly than cells at three days, owing to their consisting almost entirely of globules of lipoid. This experiment was repeated to make sure that the intracellular vacuoles were globules of fat, and a positive result was obtained. It was noted that the intracellular lipoid stained red with Sudan III as compared with the orange staining of the myelin of the normal white matter. That these are functionally active cells and not degenerating neuroglia elements seems to be borne out by the fact that, with ordinary connective tissue stains, these swollen cells show a well defined central nucleus staining normally with methylene blue (methylthionine chloride U.S.P.). It seems probable that these cells are identical with the so-called giant

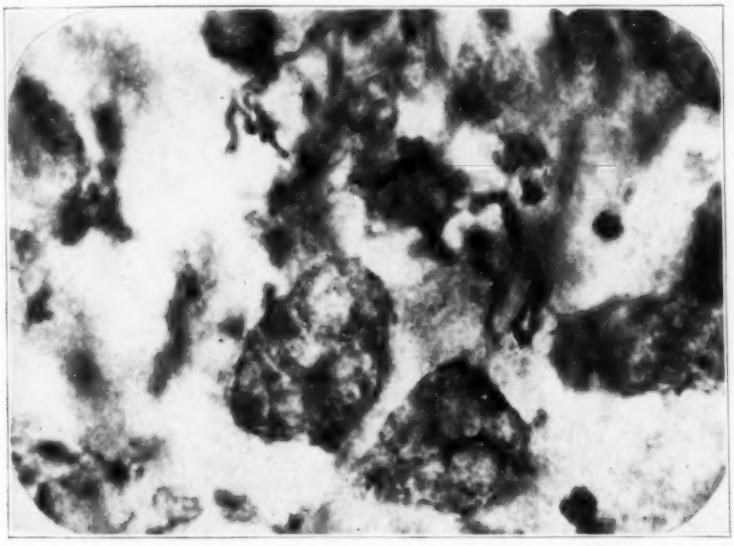

Fig. 14.—Oil-immersion photograph to show two compound granular corpuscles fully formed and filled with lipoid globules.

glia cells found in many sections of gliomas and also in areas of softening of the central nervous tissues. They probably exert their lipoid-scavenging function under many different pathologic conditions of the nervous system.

As regards the activity of the astrocytes at this period after the trauma, the most noteworthy change from the previous picture is that there is a zone immediately surrounding the wound track, which is free of these cells. Surrounding this astrocyte-free area, the macroglia shows the picture of uniformly hypertrophied cells, as shown in figures 12 and 13. The cell-free zone is explained by the fact that this area is filled with microglia cells (unimpregnated by gold sublimate). It is

possible that the astrocytes normally present in this area are phagocyted by the microglia elements. Penfield [7] found broken-off segments of astrocyte processes ingested by the swollen microglia cells. Although this observation has not been confirmed in the present experimental series, it gives a reasonable explanation of the absence of astrocytes immediately around the wound track at this stage.

Fig. 15.—Thirteen day wound. Orientation of astrocyte processes to the wound margin (below) and astrocyte-free zone adjoining the wound; low power.

Seven Days.—Two rabbits were killed one week after operation, but no new features were seen in the sections from those described for six days.

Thirteen and Fourteen Days.—In the examination of these brains, attention was focused on the astrocyte reaction. Figures 15, 16 and 17 show how conspicuously increased this reaction has become. Figure 15 is from a rabbit which died on the thirteenth day after the operation and is not a perfect specimen as the lesion was made too near the midline and caused a considerable hemorrhage into the great longitudinal

fissure from the superior saggital sinus. Hence the picture is one of reaction to compression of the brain tissue of the hemisphere rather than of reaction to a direct primary trauma. The interesting new feature here is the visible orientation of the astrocytes toward the wound. The strongest processes of the cells arise from the sides of the cell body toward and away from the wound, and the general appearance is one

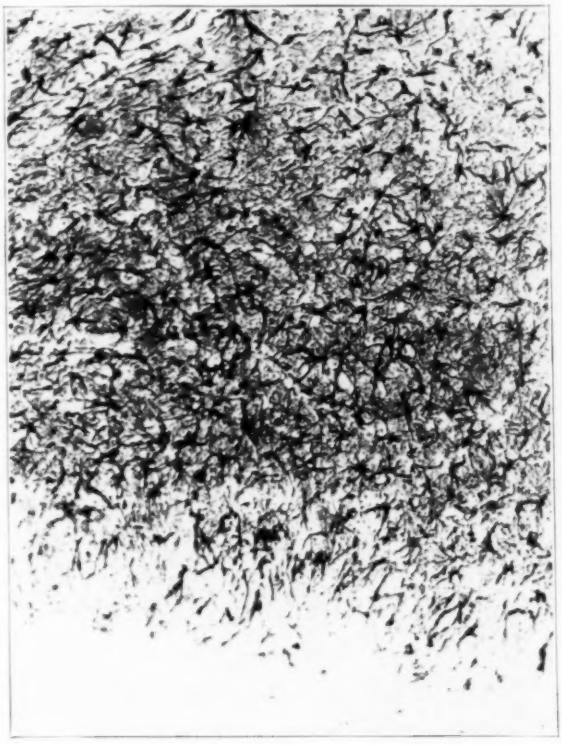

Fig. 16.—Astrocyte reaction to fourteen day, hollow-needle wound. The wound track lies below; low power.

of traction by the astrocytes in the direction of the margin of the wound. There is now a definite numerical increase over normal of reacting cells.

Figures 16 and 17 illustrate frank brain injuries a fortnight old. The reaction in figure 16 is less intense than that of figure 17, although these pictures were taken from the margin of the wound of the same rabbit's two hemispheres. The wound shown in figure 16 was produced by a hollow needle, whereas the hemisphere from which figure 17 was taken was wounded by a blunt probe. The cellular reaction is more marked in the latter picture, and a more complete stage of reaction is also shown by the early appearance of "felting" of the astrocyte

processes at the margin of the wound parallel with its long axis. These photographs afford some confirmation of Penfield's work in which less astrocyte reaction was caused by a hollow instrument which removed at the time of operation some or all of the brain tissue of the wound track, than by a blunt solid needle which left the damaged tissue of the track in situ following puncture. The influence of the presence of damaged or dead nerve tissue as a stimulus to the formation of a dense

Fig. 17.—View of the wound margin of the other hemisphere in the same case as figure 16. This wound was made by a probe. Note the somewhat more intense reaction and the early signs of "felting" of the astrocyte processes parallel to the margin of the wound; low power.

glial scar was discussed by this author and the clinical bearing of his observation dealt with in full in his recent publications.

Twenty-One Days.—At three weeks, the astrocyte reaction, as observed in this series of rabbits, has risen to its maximum; figure 18 shows the dense forest of astrocytes and their processes immediately surrounding the wound track. The function of such a proliferation

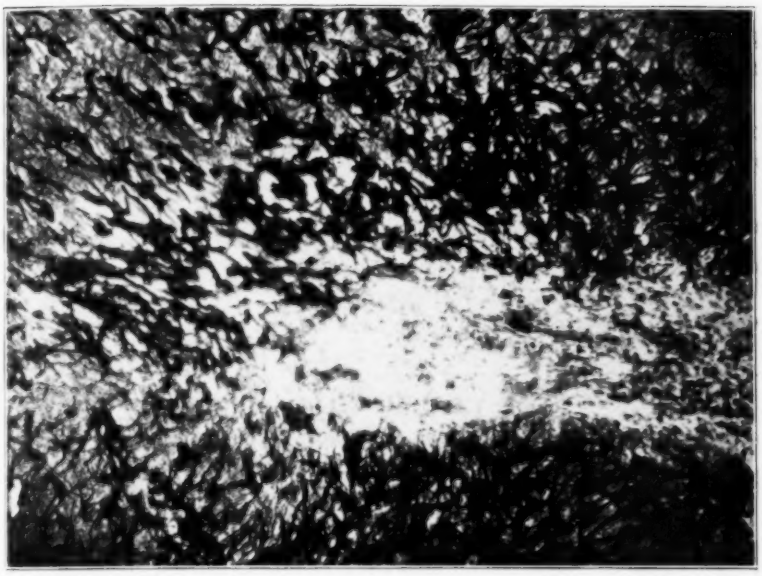

Fig. 18.—Maximum astrocyte reaction as seen around the end of the track of a three week old wound; low power.

Fig. 19.—Astrocyte reaction to a probe wound at twenty-eight days. Note the more advanced stage of "felting"; low power.

appears now definitely as a protective one, and as being an attempt to form an impenetrable barrier between damaged and normal nerve tissue.

A section of a wound of this age impregnated with silver carbonate shows the terminal stage of the microglial reaction. A few lightly impregnating compound granular corpuscles can still be seen, but they are confined in their distribution to the actual wound track, the astrocytes having moved up to the margin of the wound.

Twenty-Eight Days.—The four week wound shows a settling down of the astrocyte reaction. Examination of figure 19, the margin of a probe wound twenty-eight days old, shows a marked reduction of the

Fig. 20.—The margin of the hollow-needle wound of opposite hemisphere in the same case as figure 19. Note the less advanced stage of astrocyte reaction than in figure 19; low power.

numbers of reacting astrocytes. It is evident, however, that when these cells reach the actual margin of the wound their thickest processes spread in the long axis of the wound and thus form a protective mattress or feltwork of neuroglial processes. The majority of the hypertrophied reacting astrocytes are sacrificed in the formation of this feltwork.

Figure 20, taken from a hollow-needle wound of the other hemisphere of the same rabbit, shows a definitely earlier stage in the neuroglial reaction than that of figure 19 and approaches more closely the picture seen at three weeks; that is, the use of a hollow instrument, with the removal of a portion of the damaged brain tissue of the track, seems

to delay the time of completion of the astrocyte reaction, thus tending toward confirmation of Penfield's view that the damaged nerve tissue provides the stimulus to the astrocyte reaction. Sections taken at a considerable distance from the wound show astrocytes in actively amitotic division. In figure 21, four stages of division can be seen. In the center of the field is an astrocyte in which the nucleus alone has divided. Immediately below this is a cell the cytoplasm of which has also divided leaving two daughter cells with their nuclei in close proximity. To the right of the field are two older daughter cells. Their processes are longer and stronger, and a process of the upper cell has already become

Fig. 21.—Low power view of dividing astrocytes at some considerable distance from the track of a four week wound. Four stages of cell division can be noted as described in the text.

attached to the wall of a blood vessel by a suckerfoot. To the left of the field are two daughter cells more completely removed from each other and showing all the characteristics of adult astrocytes. Figure 22 shows early stages in the amitotic division of astrocytes as seen under oil-immersion magnification. That this active division of astrocytes was not observed in the earlier experiments is difficult to understand, but it must be presumed that astrocyte multiplication at this late stage must be for the purpose of replacing the large number of cells which have migrated to the margin of the wound, the final fate of which is to form the glial feltwork or glia scar tissue.

Fig. 22.—Two stages of astrocyte cell division. Oil-immersion.

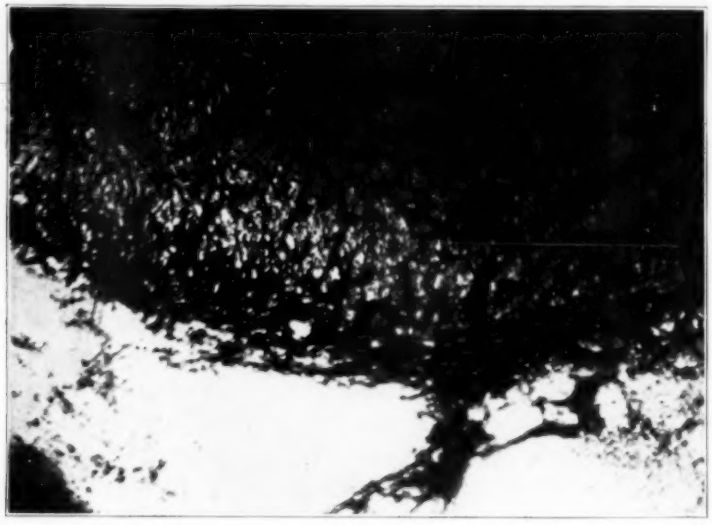

Fig. 23.—Wound margin at eight weeks. Note the well formed "felting" of astrocyte fibers parallel to the longitudinal axis of the wound track (below) and the fairly advanced stage of the formation of the glia fiber "scar."

Sixty-Two Days.—This was the longest survival period studied in this series, as it was believed that by the end of two months a brain wound was likely to have reached its final and stationary condition in the rabbit.

The main feature seen in such a wound (fig. 23) is the thickening of the glial feltwork of the margin of the wound, as contrasted with that of figure 19, and the paucity of recognizable astrocyte cell bodies in this feltwork. The number of cells surrounding the feltwork is little increased over the normal content. From the absence of cell bodies in the feltwork it seems reasonable to suppose that, after the neuroglia fibers have been laid down at the margin of the wound, their parent cell bodies disappear.

These, then, are the steps in the formation of a traumatic glial fiber cicatrix, and it is probably by the same steps that areas of gliosis or glial fibrosis are formed in many other pathologic conditions of the nerve tissues.

SUMMARY AND CONCLUSIONS

The neuroglial reaction to injury of the brain is dual—the microglial reaction and the macroglial reaction.

The microglial reaction has the following outstanding features:

1. It consists in the transformation of microglia cells into compound granular corpuscles, which, in their fully developed condition, are large, round, probably ameboid cells heavily loaded with lipoid.

2. This change takes place rapidly, being well developed three days after wounding, and reaching a maximum in six days.

3. Its function is that of phagocytosis of damaged nerve tissue (in particular of myelin) and the probable transfer of this degenerating tissue to the blood stream for disposal.

4. It is a reaction of mesoblastic tissue, similar cells which exert a similar function having been found in tissues devoid of epiblastic elements (Cone [10]).

The macroglial reaction has the following outstanding features:

1. At three days, a slight hypertrophy of astrocytes in the area of the wound is evident.

2. At six days, this hypertrophy has become more marked surrounding an area of active microglial reaction.

3. In two weeks, a marked numerical increase of hypertrophied cells is seen, with definite orientation of strong processes in a direction at right angles to the margin of the wound. The astrocyte processes have now reached the edge of the wound track.

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10. Cone, W.: Acute Pathologic Changes in Neuroglia and in Microglia, Arch. Neurol. & Psychiat. **20**:34 (July) 1928.

4. Three weeks after wounding, the astrocyte reaction is at its height.

5. Four weeks shows the earlier stages of "felting" of the astrocyte processes in the long axis of the wound to form a scar tissue of glial fibers.

6. This glial feltwork has thickened considerably by the end of two months and few cell bodies are observable in the glial "mat."

7. The purpose of this reaction is the formation of a protective scar.

8. The scar of a healed wound of the brain is the terminal result of the macroglial reaction.

TUMORS OF THE SPINAL CORD

PROBLEMS IN THEIR DIAGNOSIS AND LOCALIZATION; PROCEDURES FOR THEIR EXPOSURE AND REMOVAL *

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The Diagnosis of Tumors of the Spinal Cord.
- High Cervical Growths: Clinical Features.
- Dissociation of Tactile from Pain and Temperature Sensibility.
- The Upper Limit of Disturbances of Sensibility; Discrepancies Between the Sensory Level and the Affected Segments of the Cord.
- Shifting of the Upper Limit of Sensory Loss.
- Examinations Before and After Lumbar Puncture.
- The Protein Content of the Spinal Fluid.
- Lumbar Manometric Tests.
- The Indications for Iodized Oil.

Exposure and Recognition of Tumors of the Spinal Cord.
- Advantages of Incision of the Dura Without Injury to the Arachnoid.
- The Varieties of Arachnoiditis.
- Exploration of the Subarachnoid Space.
- The Relation of Extramedullary Tumors to the Arachnoid.

The Removal of Intradural Extramedullary Tumors

The Removal of Extradural and Intradural Tumors Adherent to the Dura.

THE DIAGNOSIS OF TUMORS OF THE SPINAL CORD

As for the study of other diseases, so for the diagnosis and localization of tumors of the spinal cord, a carefully taken clinical history and repeated examinations are of primary importance. The proper evaluation of seemingly insignificant facts in the story told by the patient and the correct interpretation of changes from the normal found at the examinations and by laboratory and clinical tests are not always easy.

High Cervical Growths: Clinical Features.—In compression of the upper cervical segments of the cord by a new growth, disturbances of the functions of some of the cranial nerves are not as unusual as they were formerly believed to be. Headache is occasionally a prominent symptom. Headache and disturbances of the cranial nerves may be due to a slight amount of interference with the circulation of the cerebrospinal fluid in the cranial cavity or may be directly caused by the extension of a growth through the foramen magnum into the posterior cranial fossa.

* Submitted for publication, March 11, 1929.

* Read, in part, at a Meeting of the New York Academy of Medicine, Section on Neurology, Feb. 12, 1929.

If the headache has been of longer duration than the symptoms of the spinal cord, the tumor may have originated in the posterior cranial fossa and have extended downward into the vertebral canal. A growth that lies both above and below the foramen magnum may not cause any cranial symptoms; on the other hand, nystagmus, inequality of the pupils and anesthesia of the cornea may be observed in patients with a tumor entirely limited to the vertebral canal, perhaps over segments well below the foramen magnum.

A subjective sensation of intense cold in one or more limbs is often complained of by those suffering from compression of the upper segments of the cervical cord. It occurs most often in the toes or foot of the contralateral lower extremity, although both lower or the contralateral upper limb may also be affected. The patient is often awakened at night and greatly disturbed during the day by the feeling of intense cold, and usually states that the limb is not cold to the touch and that little relief is obtained by warmth applied to the affected part. This symptom may occur early, before there are any motor or sensory disturbances, and it has usually disappeared by the time distinct changes in the tendon reflexes and of sensibility can be found.

This sensation of intense cold, referred to the peripheral parts of one or more limbs, has been observed by me only in patients with extramedullary compression of the uppermost segments of the spinal cord; tingling and other painful paresthesias referred to the contralateral limbs occur, however, not infrequently in extramedullary tumors at other levels and in intramedullary disease of the spinal cord.

Dissociation of Tactile from Pain and Temperature Sensibility.—The experiences of recent years have demonstrated that in many patients with tumors high in the cervical cord, tactile sensibility may be little if at all affected; at the same time there is marked diminution in the power to feel and to recognize the pain of a pin prick and variations in temperature.

In my experience, in ten of forty-two cases of tumor of the cervical cord (24 per cent), tactile sensibility was undisturbed over the trunk and extremities, while pain and temperature sensibility was markedly involved; in fifteen patients (36 per cent) the ability to appreciate light touch was only slightly affected; in sixteen patients (38 per cent) all modalities of cutaneous sensibility were equally diminished or were lost altogether. In disease of the cervical cord, therefore, the so-called syringomyelic dissociation of the cutaneous sensibilities, by itself, cannot be accepted as evidence which favors an intramedullary as against an extramedullary tumor.

The Upper Limit of Disturbances of Sensibility; Discrepancies Between the Sensory Level and the Affected Segments of the Cord.—

In tumors in the thoracic regions of the spinal cord, the upper limit of sensibility disturbances is sometimes ill defined, and it may fade out gradually, so that the level at which a laminectomy for the removal of the growth has to be performed is difficult to determine with accuracy.

In some patients there is an area of normal sensibility between the upper level of sensory loss and disturbances due to root involvement. In others, in whom there are no radicular signs, the upper limit of disturbances of sensibility—though distinct—corresponds to a lower segment of the cord than that actually involved by the new growth.

The afferent fibers which enter in the posterior spinal roots require at least from one to two segments before they reach the anterior part of the cord on the opposite side. In compression of the cord from in front at the level of any segment, therefore, the sensory fibers from the corresponding dermatomic area have not yet reached the more ventral part of the cord on the opposite side (fig. 1) and may therefore not yet be involved by the pressure.

The more ventral the compression, i.e., the more the pressure of the tumor on the spinal cord is exerted from before backward, the more often must this apparent discrepancy between the upper level of sensory disturbances and the segment or segments actually involved be reckoned with.

Shifting of the Upper Limit of Sensory Loss.—In rare instances of slowly increasing pressure on the spinal cord, there may be a gradual shifting upward of the upper level of disturbances of sensibility as occurs in progressive intramedullary disease.

If there are no distinct spinal root disturbances, or unless the localization has been made certain by means of x-ray plates taken after an injection of iodized oil 40 per cent, or the patient is subjected to surgical intervention late in the course of his disease, such "false localizing signs" may lead to an operation at an incorrect level. Errors in localization due to this gradual shifting of the upper level of sensibility disturbances occur rarely, because in the majority of extramedullary tumors the upper limit of sensory loss remains at a constant level. During the past ten years, however, I have seen three examples of this cephalad progression of the sensory level.

In a patient recently operated on, there was at first a distinct sensory level at the eleventh to the twelfth thoracic dermatome; one month later, it was just as definitely at the seventh to the eighth thoracic dermatome; finally, again about one month later, the disturbances of sensibility involved the lower extremities and the trunk up to the fourth thoracic dermatome. The tumor was removed from this level of the cord.

Many of these incongruities in the sensibility disturbances are explicable as a consequence of the lamellar arrangement of the fibers

in the spinothalamic tracts—the grouping of fibers in the pathways for the trunk and limbs and parts of limbs (Foerster, Antoni, Tilney and Elsberg, Spiller and others), and, as already mentioned, as the result of the more or less oblique crossing of the fibers which enter in the posterior spinal roots in one segment and join the lateral spinothalamic tracts on the opposite side of the spinal cord at a higher segmentary level.

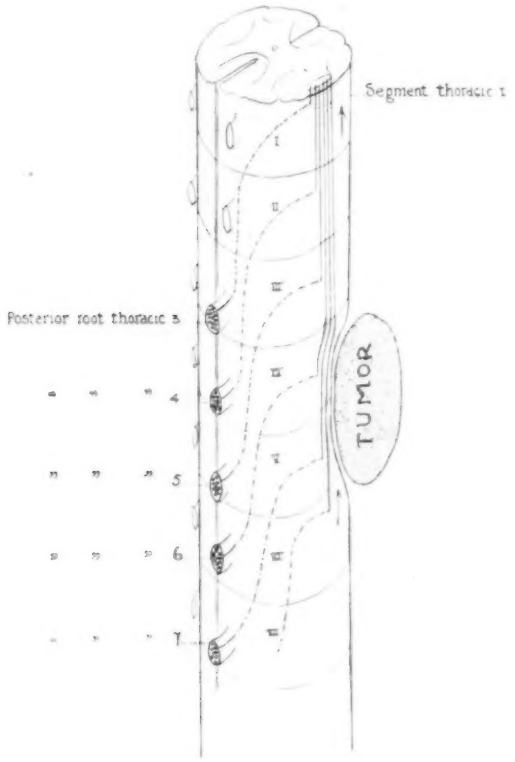

Fig. 1.—How a ventrally placed tumor of the spinal cord may cause sensory level signs which point to lower segments of the cord than those actually compressed (diagrammatic). In the case here represented, in a growth at the fourth and fifth thoracic segments, the upper level of sensory disturbance pointed to a compression of the sixth and seventh segments, because the pressure of the tumor had been insufficient to affect the pathways of the fourth and fifth posterior roots.

Examination Before and After Lumbar Puncture.—In every case in which tumor of the spinal cord is suspected, no matter whether a definite sensory level has not been found, the patient should be reexamined after a lumbar puncture has been performed. Not only may the upper limit of disturbances of sensibility become more distinct, but the boundary between normal and altered sensation may have

shifted upward so that the operation for the exposure and removal of the tumor will have to be performed at a higher vertebral level. I consider these examinations—made before and after fluid has been removed by lumbar puncture—important both for correct and for more exact localization.

The Protein Content of the Spinal Fluid.—The diagnosis of compression of the spinal cord by tumor has been greatly furthered by the examination of the pressure conditions and by chemical examination of spinal fluid obtained by lumbar and sometimes by cistern puncture. Much credit is due to Ayer and Fremont-Smith for the simple and practical test for total protein which they devised. This has, to a considerable extent, superseded in importance the test for globulin, and is now used as the standard test for protein in many of the neurologic and neurosurgical clinics in this country.

The results of the determination of the total amount of protein in the fluid obtained by lumbar puncture, when taken in conjunction with the data obtained by refined manometric tests, are important aids in the diagnosis of compression of the spinal cord, and in the distinction between compression of the spinal cord and other diseases of the spinal cord and membranes with level symptoms and signs. The test has also been of some use in the differentiation between extradural and intradural tumors.

The earlier in the course of the disease that the patient is examined —i.e., the smaller the tumor and the less the degree of pressure on the cord—the lower will be the protein content of the spinal fluid. Theoretically, however, a soft neoplasm of a larger size should cause less pressure on the vessels of the spinal cord than a smaller one of more firm consistency, but the study of my records has not, thus far, shown any regular difference in the total protein content of the spinal fluid between tumors of soft and those of firm consistency.

In the extradural ventral chondromas, which are usually small, there may be little, if any, increase in the total protein content, but in the majority of other extradural tumors, the amount of protein will be found to vary between 40 and 150 mg.—most often between 50 and 100 mg.[1] The values, however, may be much higher in extradural compression by tuberculous bone disease or in fractures of the vertebrae.

In more than 80 per cent of the cases of intradural extramedullary growths in which operation was performed in the neurosurgical clinic of the Neurological Institute, the total protein values were between 150 and 450 mg.; in less than 20 per cent the protein content varied between 50 and 90 mg. In other words, while a relatively slight increase

1. The upper limit of normal in the determination of the total protein content by the Ayer method is 40 mg.

in the total protein content may be found in intradural growths, especially early in their course, such a low protein value is more frequent in those on the outer surface of the dura. When there is a question, therefore, whether a neoplasm is extradural or intradural, the presence of more than 150 mg. of protein in the spinal fluid points rather to one inside the dural sac.

In a series of almost 200 cases of verified tumor of the spinal cord, there has been one patient in whom, in spite of complete subarachnoid block by the lumbar manometric tests, the total protein content was within normal limits.

As this case was exceptional, it is given in abstract.

A man, aged 52, had advanced loss of power and sensation over the entire trunk and extremities, with the signs of compression of the spinal cord at the second and third cervical segments. The history of the patient's illness dated back more than two years, during which period there had been a slow progression of subjective and objective disturbances followed by a more rapid advance of symptoms during a period of two months before his admission to the New York Neurological Institute.

Manometric tests showed complete subarachnoid block, but the spinal fluid was not xanthochromic; the total protein content was 40 mg., and the globulin test 1+.

At operation, a subarachnoid extramedullary tumor, 3 by 2 by 2 cm., of firm consistency, which had deeply indented the cord, was removed from the level of the third cervical segment.

In this patient, the progression of symptoms with the demonstration of a complete subarachnoid block pointed to an increasing compression of the cord by a tumor, but the absence of an increase of protein made one think of the possibility of an extradural ventral chondroma or even of some other lesion with adhesions of the arachnoid and a block in the subarachnoid space.

The question might have arisen whether—even in the absence of an increase in the total protein content—a 1+ globulin reaction should have been considered of significance with reference to the diagnosis of compression by tumor. According to my experiences, an increase of globulin without an increase of the total protein content may occur in cerebrospinal syphilis, arachnoid adhesions, neuritis of the cauda equina and other conditions.

Lumbar Manometric Tests.—The manometric test, originally described by Queckenstedt for the diagnosis of subarachnoid block in tumors of the spinal cord, has been studied by many investigators. In the clinics of the New York Neurological Institute, Dr. Stookey and his collaborators [2] have added greatly to the diagnostic value of the test

2. Stookey, B.: Adhesive Spinal Arachnoiditis Simulating Spinal Cord Tumor, Arch. Neurol. & Psychiat. **17**:151 (Feb.) 1927. Stookey, B.; Merwarth, H. R., and Frantz, A. M.: Surg. Gynec. Obst. **41**:429, 1925. Stookey, B., and Klenke, D.: Study of the Spinal Fluid Pressure in the Differential Diagnosis of Diseases of the Spinal Cord, Arch. Neurol. & Psychiat. **20**:84 (July) 1928.

by their investigations. The original procedure of Queckenstedt forms only a small part of the complete manometric tests as done today, and it is therefore advisable to speak of the tests as the "lumbar manometric tests." Dr. Stookey devised the method of "touch compression," showed that the "pressure index" is of importance and described a method for charting graphically the results of the various procedures. The investigations have demonstrated the significance of the time required for the rise of the column of fluid in the manometer when the jugular veins are compressed and for the fall when the pressure is released. Thus it has been possible to recognize a number of varieties of incomplete subarachnoid block, and thereby to advance the knowledge of subarachnoid block in many localized diseases of the spinal cord and membranes.

As in all laboratory and diagnostic procedures, the lumbar manometric tests have certain limitations. When an extramedullary or extradural tumor is still extremely small, it may not invade the vertebral canal sufficiently to interfere with the flow of fluid in the subarachnoid space, and naturally at this early stage manometric tests may be entirely negative. I have encountered such a condition in some of the extradural ventral chondromas and in a few small intradural growths.

When the manometric tests are done carefully, a slight interference with the flow of fluid in the subarachnoid space above the level where the lumbar puncture has been done is sometimes demonstrable even before there are any changes in the cerebrospinal fluid such as an increase of protein or a slight xanthochromia. If, however, the block is below the needle, as occurs in tumors which involve the sacral roots of the cauda equina, the tests usually fail to show any subarachnoid block.

In suspected tumors of the cauda equina, the lumbar puncture should be done either through the fifth interspace, or, whenever possible, the lowermost part of the subarachnoid sac should be punctured at the level of the first or even second sacral vertebra, i.e., a sacral puncture should be performed.

In several instances it has been possible not only to demonstrate a low subarachnoid block but also, by means of a double puncture, to determine the vertebral level of the new growth. The needle was first introduced below the fourth or fifth lumbar spine when either no fluid was obtained or a more or less complete manometric block demonstrated; a second puncture was then done below the first lumbar spine, and at this level the manometric tests showed no block.

For some years, efforts have been made in a number of clinics, and also in our own, to devise a simple apparatus for taking kymographic tracings of the manometric tests. When a satisfactory apparatus will

have been worked out, still finer differences of pressure in the various types of partial block ought to be demonstrable, and it is not at all improbable that alterations in the manometric curves will be found when the length of the spinal subarachnoid space has been diminished by a tumor in the lower lumbar or sacral parts of the vertebral canal, i.e., when the block is below the situation of the lumbar puncture.

The method of puncture of the cisterna magna, so brilliantly worked out by Ayer, has been found to have a large field of usefulness. For the diagnosis of spinal cord compression and of subarachnoid block, however, the combined cistern and lumbar puncture as described by Ayer, with simultaneous manometric studies in the two locations, and the examination of the fluids removed from the two loci, has rarely been necessary in my experience. An occasion might arise, however, in which this procedure would be a valuable and necessary diagnostic aid.

The Indications for Iodized Oil.—Without desiring in any way to detract from the importance of the discovery of Sicard and Forestier and of their work and that of their followers, I believe that iodized oil has been used far more often than is necessary, and I am in complete accord with the views expressed by de Martel.[3] Iodized oil is never necessary for the diagnosis, although it may be valuable for the localization of a growth. By a well taken history, repeated neurologic examinations, carefully made manometric tests and examination of the fluid obtained by lumbar puncture, the correct diagnosis can usually be made.

If there is not the slightest evidence of a subarachnoid block, nothing will be gained by an injection of iodized oil, for in such a case the oil will freely pass upward and downward within the subarachnoid space.

In the majority of instances of tumor of the cord, the sensory, motor and radicular changes are such as to localize the growth definitely.

In tumors between the roots of the cauda equina it is often difficult, in spite of the use of the double puncture already described, to decide whether the growth lies near the origin from the cord of the affected spinal roots or farther caudad, and in these patients the exact vertebral level of the tumor can be determined by a lumbar injection of iodized oil.

Cases in which there is a subarachnoid block by manometric tests, but in which no sensory level signs or radicular disturbances can be found, do occur—although they are rare—and in these patients an injection of iodized oil will be of decisive value.

In almost 200 hundred patients with tumor of the spinal cord, I have seen three in whom there was an upward shifting of the upper

3. De Martel: Rev. neurol. **1**:496, 1927.

level of disturbances of sensibility during the course of months.[4] In these patients, an injection of iodized oil would have exactly localized the growth at a time when the upper limit of sensory loss would have pointed to a lower cord segment.

Even if the segment level of the compression has been determined correctly, there still remains a possibility that an operation would be done a little too high or too low—on account of the variations in the relation of cord segments to vertebrae. There is no doubt that iodized oil will show the surgeon exactly where the laminectomy should be performed, and if there were not some objections to the indiscriminate use of this substance, the localization by means of iodized oil would be an ideal method.

Iodized oil, however, is a distinct irritant to the meninges. In a number of instances in which I have exposed the cauda equina after injections of iodized oil had been made, the roots were found to be markedly congested and inflamed, and I have observed a similar acute inflammatory change of the pial covering of the cord in patients on whom I have operated after injections of iodized oil. I consider it dangerous, therefore, to make injections of iodized oil into a patient when the symptoms and signs of a lesion of the cord are so far advanced that it is a question whether the patient has already a complete transverse (and therefore an irremediable) lesion of the cord. In such a case the added acute inflammatory process of the leptomeninges can only do harm.

Iodized oil is a substance which remains in the subarachnoid sac for years, and sufficient evidence has not yet been produced that the oil is ever completely absorbed. The fact that after one or several years the x-ray shadow can no longer be demonstrated may mean only that the iodine but not the oil itself has disappeared.

As far as can be determined from my personal experiences and from the reports in the literature of the subject, permanent ill effects from injections of iodized oil have been observed only occasionally. Nevertheless, iodized oil should be used only when all other methods of examination have failed to localize a subarachnoid block, and at the operation every effort should be made to remove as much of the oil as possible.

This statement will no longer apply if and when a nontoxic and nonirritating fluid has been discovered which will diffuse through the cerebrospinal fluid, show with the roentgen rays and be absorbed from the subarachnoid space. The discovery of such a fluid is the ideal toward which one must strive. When it has been found, it will be freely used for the localization of tumors and other diseases of the spinal

4. A short account of one of these cases was given in an earlier part of this paper.

cord and of the brain. It could be used not only to localize a tumor of the spinal cord, but also, by injections both above and below the growth, to give the surgeon information as regards both the size of the neoplasm and the minimum number of laminae that would have to be removed in order to expose and remove the growth.

EXPOSURE AND RECOGNITION OF TUMORS OF THE SPINAL CORD

Advantages of Incision of the Dura without Injury to the Arachnoid.—Normally, the arachnoid is not adherent to the inner surface of the dura excepting where each spinal root perforates the dural sac, but the outer surface of the arachnoid is in close contact with the dura because of the fluid in the subarachnoid space. In most instances, therefore, in the exposure of the spinal cord it is possible to incise the dura without injury to the arachnoid if proper care is taken. This has been found to have certain definite advantages (Elsberg, Leriche and others).

Unless there is a tumor or other lesion in or above the area exposed, respiratory movements of the fluid in the subarachnoid space can usually be observed, and the cord and the blood vessels on its posterior surface can be clearly seen through the transparent arachnoid. One can at once determine whether the vessels are normal in size and arrangement, or whether the veins are dilated and tortuous, and can recognize changes in the size and color of the cord. This will allow one to differentiate between an extramedullary and an intramedullary lesion. In the former, the appearance of the posterior spinal vessels is characteristic, while in the latter, the cord is often yellow, the pattern of the blood vessels on its surface greatly altered and the cord either shrunken or so much enlarged that the arachnoid is tightly stretched over it.

The appearance presented by an enlarged or swollen cord from intramedullary disease, however, may be simulated when the spinal cord is pushed backward by a ventrally located extradural or intradural tumor. In such a case, not only may the involved part of the cord be dislocated backward, but it may appear enlarged and broadened as if from a lesion within its substance.

The Varieties of Arachnoiditis.—By the separate incision of the dura, the spinal cord surrounded by the subarachnoid fluid is protected during manipulations incident to exploration, and finer changes in the arachnoid such as cloudiness, thickening and adhesions can be better recognized and dealt with.

In rare instances, there may be a primary adhesive arachnoiditis, or calcareous plaques in the arachnoid may be adherent to the inner surface of the dura. Adhesions between the dura and the arachnoid or between the latter membrane and the pia mater on the surface of the spinal cord are more often due to tumor or are secondary to an inflam-

matory process which may have either been entirely extradural or intradural involving both spinal cord and meninges.

There are two varieties of secondary adhesive arachnoiditis; both frequently occur together. In one variety, the outer surface of the arachnoid is adherent to the dura and the subarachnoid space is more or less free. This is most often encountered after trauma to the vertebrae and in some extradural tumors. In the second variety, the arachnoid and pia mater are bound together by adhesions, so that over a more or less localized area the subarachnoid space is partly or completely obliterated. This type of adhesive arachnoiditis is rarely, if ever, a primary lesion; it is usually secondary to an intramedullary disease such

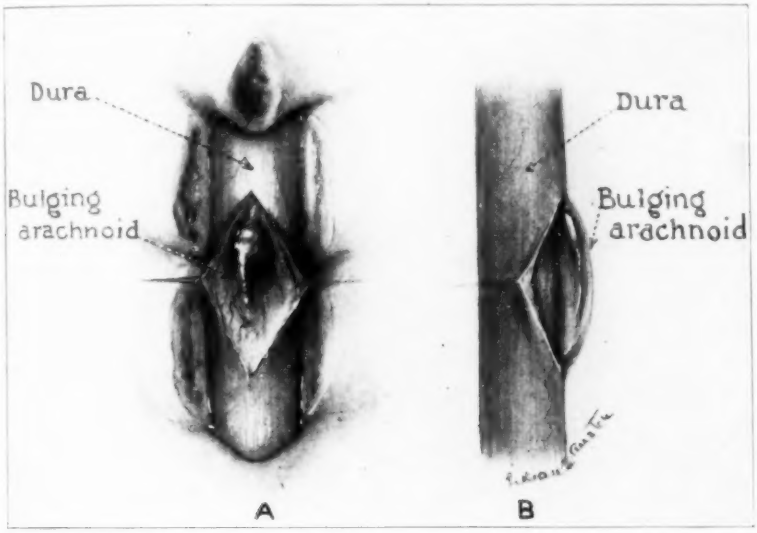

Fig. 2.—The appearance of the bulging arachnoid on compression of the jugular vein; *A*, from behind; *B*, from the side. By this manipulation it is possible to determine that there is no subarachnoid block above the exposed segment of the cord.

as infective myelitis, spinal syphilis, hematomyelia or syringomyelia and intramedullary new growths, and may be found after a spinal trauma.

Exploration of the Subarachnoid Space.—If a suspected extramedullary tumor has not been exposed by the incision of the dura, the veins of the patient's neck should be compressed by an assistant before any further exploration is made. In the absence of a distinct block at a high level, compression of the jugular veins will be followed by distention of the arachnoid which will often herniate through the incision in the dura (fig. 2). By this procedure the absence or presence of a block at a higher level may help to localize the growth.

The ideal way to explore the vertebral canal in searching for a tumor is to pass the probe or searcher upward and downward outside the arachnoid sac. If the arachnoid is incised separately, the cut edges can be grasped with fine forceps, and the searcher passed also into the subarachnoid space both in an upward and a downward direction. If the arachnoid has been widely incised before the probe or catheter is used, the exploration is always extra-arachnoid and subdural.

The Relation of Extramedullary Tumors to the Arachnoid.—From the time when I began to make the separate incision of the dura a regular procedure, it has been possible to obtain a better insight into the relation of tumors of the spinal cord to the different membranes. Intradural extramedullary tumors may be either outside or inside the arachnoid sac. In the former instance they may be adherent only to the inner surface

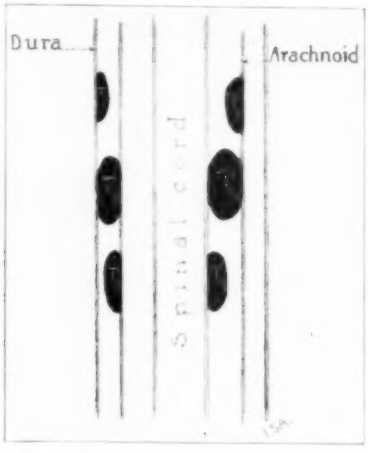

Fig. 3.—The relations of tumors outside and inside the arachnoid: T_1, T_2, T_3, extra-arachnoid growths; T_1, T_2, T_3, subarachnoid growths.

of the dura so that they can be raised up with the dural flaps from the intact arachnoid; they may be adherent to both dura and arachnoid, or may be attached to the latter membrane but not to the dura (fig. 3).

Tumors within the arachnoid may be adherent only to that membrane, to both arachnoid and pia mater, or only to the pia mater on the surface of the cord (fig. 3).

Both meningeal and perineural fibroblastomas occur most often inside the arachnoid membrane, i.e., they are most frequently subarachnoid growths.

When such a subarachnoid growth is exposed, it is seen to be covered by the arachnoid, and if it is attached to that membrane the cerebrospinal fluid will fill the space above and below the tumor to the point where the adhesions exist.

All this has led to the recognition that the growths classified as meningeal fibroblastomas (meningiomas, endotheliomas) vary in their relation and attachments to the membranes of the spinal cord,[5] and has given a better understanding of the origin of this much discussed form of tumor of the central nervous system.

THE REMOVAL OF INTRADURAL EXTRAMEDULLARY TUMORS

In every case in which a tumor of the cord is adherent to or lies embedded in the cord, the separation of adhesions and the liberation of

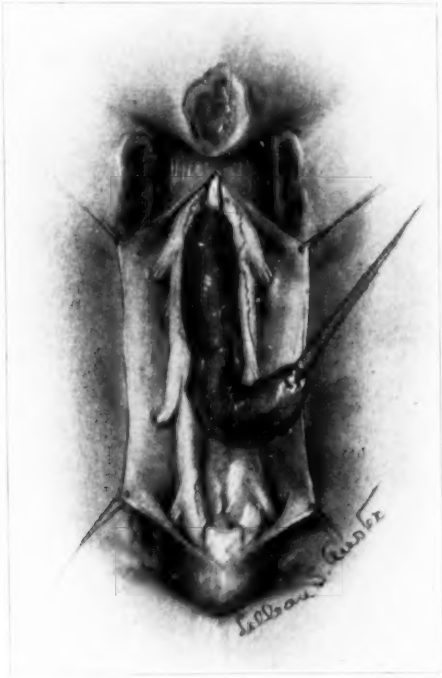

Fig. 4.—The manner in which an extramedullary tumor on the posterior surface of the cord can be raised up by means of a traction suture.

the growth requires both care and delicacy in manipulations. It is always inadvisable and dangerous to draw aside, by means of an instrument, a cord already damaged by the prolonged pressure of a neoplasm.

In growths that lie on the posterior or the posterior and lateral aspects of the cord, traction on the tumor can often be best accomplished by means of a suture passed through the tumor itself (fig. 4). With growths in these locations, especially in those which lie outside the arachnoid or inside that membrane and not adherent to the pia, the dis-

5. Elsberg, C. A.: Surg. Gynec. Obst. **46**:1, 1928.

tention of the subarachnoid space with fluid by compression of the veins of the neck by an assistant may actually float up or raise the tumor away from the cord (figs. 5 and 6). The same procedure is sometimes useful in delivering the upper part of a growth out of its bed after the lower part has been liberated (fig. 7).

In some cases the gentle injection of a stream of fluid into the subarachnoid space underneath the tumor will be found useful in raising the tumor away from the cord.

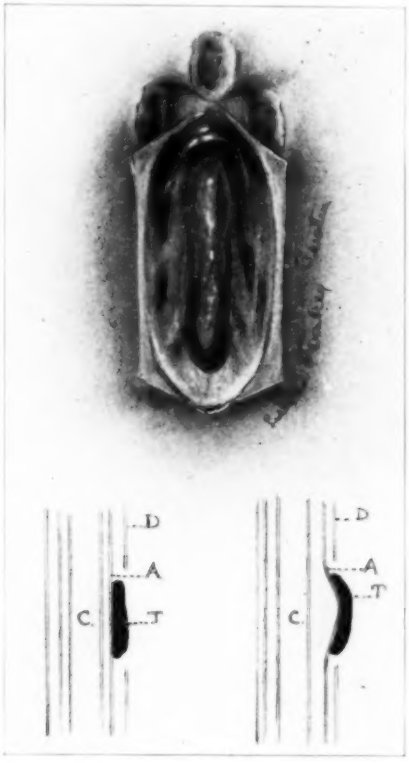

Fig. 5.—The effect of compression of the jugular veins; a tumor outside the unopened arachnoid is raised away from the spinal cord. In this and figure 6, *C* represents the spinal cord; *T*, the tumor; *A*, the arachnoid, and *D*, the dura.

If the growth lies on the ventral or ventrolateral aspect of the cord, the latter must be raised, rotated and carefully drawn away from the tumor by traction on a divided slip of the dentate ligament. Although a combined procedure is ofter necessary, it is always safer to draw the tumor away (if this can be accomplished without making additional pressure on the cord) rather than to draw the cord away from the tumor.

Additional room for manipulations may be gained by the incision of the dura in a transverse direction by the division of one or several slips of the dentate ligament or even of one spinal root.

THE REMOVAL OF EXTRADURAL AND INTRADURAL TUMORS ADHERENT TO THE DURA

Many primary and secondary extradural and intradural new growths either are connected with the dura by fine adhesions which can be easily

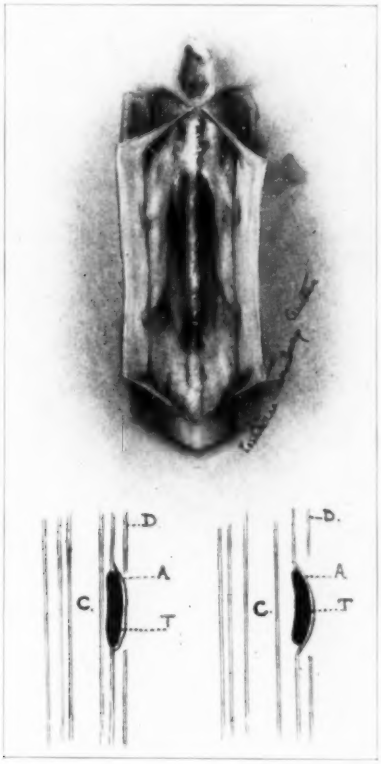

Fig. 6.—The effect of compression of the jugular veins; a growth inside the unopened arachnoid is raised away from the cord.

separated or are not adherent to the dura. With the exception of some ventrally situated chondromas, these tumors can be removed without injury to the dura mater. When, however, the growth is more firmly adherent to the outer surface of the dura, a piece of that membrane must be excised if recurrence is to be prevented. In some cases it is possible to separate the dura into two layers and to excise only the outer layer with the neoplasm.

In intradural meningiomas or neurofibromas which are broadly attached to the inner surface of the dura, I have occasionally removed only the inner layer of that membrane with the growth, so that at the close of the operation the edges of the incision in the dura could again be united by suture without tension or pressure on the cord. In none of these patients has there been any evidence of recurrence.

Such a partial layer excision, however, may be attempted only if one is certain that one is dealing with a benign growth. At my suggestion, Dr. Davidoff is making a study of the dura in intracranial and spinal

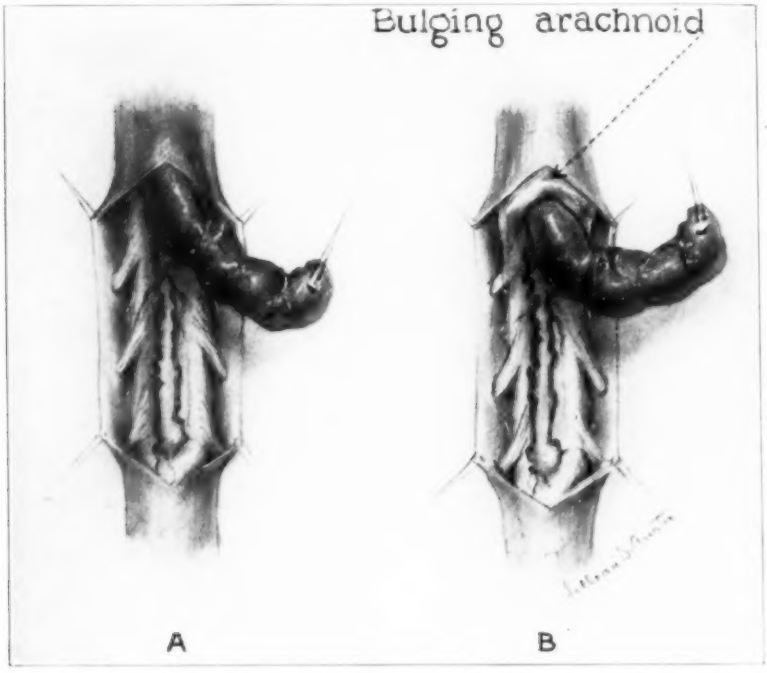

Fig. 7.—*A*, a tumor which has been partly freed from the cord and raised up by a traction suture. The upper pole of the growth extends beyond the upper end of the dural incision. *B*, the upper pole of the tumor is delivered by compression of the jugular veins and distention of the subarachnoid space.

tumors which are adherent to the dura in order to determine how often and in which cases the entire thickness of the membrane is invaded by tumor cells. Thus far only intracranial meningioma material has been studied. The investigation, as far as it has progressed, shows that in some cases the growth is attached to the surface of the dura and no tumor cells can be found within the substance of that membrane; in other instances, however, tumor cells infiltrate the layers of the dura. From the studies thus far made, and until a large amount of material has been

subjected to careful microscopic scrutiny, it will be safer to excise a piece of the entire thickness of the dura if a growth is firmly attached to it.

For the approach to and the removal of the extradural intervertebral disk chondromas which lie on the ventral aspect of the dura, I have generally performed the transdural operation which was suggested by me many years ago. In many instances the tumor is so situated near the midline that it can be found only after incision of the dura and exploration within the dural sac. For the exposure and removal of these extradural midline growths, the cord has to be drawn to one side by traction on a divided slip of the dentate ligament.

This can sometimes be done without injury to the arachnoid, but more often that membrane has to be incised and the cerebrospinal fluid allowed to escape before the prominence of the ventral dura which indicates the exact location of the extradural chondroma comes into view. The dura is then incised over the prominence of the growth, and the latter removed in one piece or in fragments.

In some instances, after the dura has been incised and the growth located, it is possible actually to remove the growth by an extradural route. If this is done, however, the greatest care must be taken that undue pressure is not made on the cord within the dural sac.

CHANGES IN THE SPINAL CORD IN ANEMIA

A CLINICOMICROSCOPIC STUDY *

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AND
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INTRODUCTION AND HISTORICAL MATTER

In most of the leading textbooks of neurology and in present day clinical teaching, the statement is advanced that the pathologic changes in the spinal cord known as "subacute combined degeneration," "combined sclerosis" or "subacute funicular myelopathy" not only are present in pernicious anemia but may also be seen in other forms of anemias.[1] With this in view a number of cases of pernicious anemia and secondary anemia in various diseases were investigated and, as will be shown, this statement will have to be revised.

In discussing the relationship of diseases of the spinal cord to anemias it will be of advantage first to adhere to a classification of the diseases of the blood which corresponds to present day knowledge in hematology, and second to define the pathologic picture of "subacute combined degeneration."

For the classification of anemias the scheme of Morawitz and Denecke [2] was adopted.

A. Anemias caused by increased loss of blood:

1. Posthemorrhagic anemias
   (*a*) Acute
   (*b*) Chronic
2. Anemias caused by increased decomposition of blood in the body (hemolytic or hemophthisic anemias)

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* From the Neuropathology Laboratory, Montefiore Hospital, New York.

* Read at a meeting of the New York Neurological Society, April 2, 1929.

1. Henneberg, R.: Die funikuläre Myelitis und die anämische fokale Leukomyelitis, in Lewandowsky, M.: Handbuch der Neurologie, Berlin, Julius Springer, 1911, vol. 2, p. 769. Oppenheim: Textbook of Nervous Diseases, London, T. N. Foulis, 1911, vol. 1, p. 189. Wechsler, I. S.: Textbook of Neurology, Philadelphia, W. B. Saunders Company, 1927, p. 140. Dana, C. L.: Textbook of Nervous Diseases and Psychiatry, New York, William Wood & Company, 1918, p. 328.

2. Morawitz, P., and Denecke, G.: Blut und Blutkrankheiten in Bergmann and Staehelin: Handbuch der inneren Medizin, 1926, vol. 4, pt. 1, p. 91.

(*a*) Anemias due to hemolytic toxins or methemoglobin-forming toxins (pyridine, phenylhydrazine, nitrobenzene, potassium chloricum, etc.)

(*b*) Anemias in the presence of *Bothriocephalus latus,* and rare cases of hemolytic anemias in the presence of other worms

(*c*) Anemias of unknown cause

(1) Acute, mostly with leukocytosis (rare)

(2) Chronic (Biermer's, Addison's anemias), so-called progressive pernicious anemia

(3) Chronic hemolytic icterus

(*d*) Hemolytic anemias in the puerperium, syphilis, malaria and in rare cases of carcinoma

B. Anemias due to decreased formation of blood:

1. Myelopathic—destruction of the bone marrow through tumors, osteosclerosis, etc.

2. Hypoplastic, e. g.,

(*a*) In cachectic disease, inanition, i. e., most of the cases of anemia in tumors of different organs

(*b*) Aplastic or regenerative anemia (Ehrlich, Pappenheim) from unknown cause

C. Chlorosis and anemias in childhood

The pathologic changes in the spinal cord known as subacute combined degeneration were first described in 1878 by Kahler and Pick.[3] An exhaustive review of the literature up to 1911 is given by Henneberg [1] and a more recent review by Mueller [4] in 1925. It is generally agreed that the term "funiculitis" is misleading. There is no systemic degeneration affecting the long fiber tracts in the posterior and lateral columns. The disease process in most cases of disseminated myelitis begins with small foci scattered throughout the posterior and lateral columns of the thoracic portion of the cord and gradually spreads upward and downward. In the early stages, secondary degeneration of the ascending fibers in the cervical region and of the descending fibers in the lumbar region appears following the destruction of the corresponding axis cylinders in the dorsal segments. It is only in later stages of the disease that the pathologic picture of "funicular myelitis" is also seen in the anterior columns in the cervical and lumbar segments.

There is a difference of opinion as to the primary lesion in the spinal cord and as to its sequelae. Earlier investigators emphasized the changes in the vascular system such as fatty degeneration of the vessel walls and petechial hemorrhages, and considered the fiber degeneration as secondary.

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3. Kahler and Pick: Ueber kombinierte System Erkrankung des Rückenmarks, Arch. f. Psychiat. **8**:251, 1878.

4. Mueller, E.: Erkrankungen des Rueckenmarks, in Handbuch der Inneren Medizin, Berlin, Julius Springer, 1925, vol. 5, pp. 559-581 and 765-774.

Among present day neuropathologists, one group (Wohlwill,[5] Shimazono,[6] Spielmeyer,[7] and others) claims that a hypothetic toxin acts primarily on the axis cylinders causing their destruction, with secondary involvement of the myelin sheaths and reactive phenomena of the glia; while a second group (Henneberg,[8] Hassin,[9] Globus,[10] and others) insists on the primary affection of the myelin sheaths, the destruction of which produces secondary swelling and fragmentation of the axis cylinders with the ensuing phenomena of "Abbau" reactions. None of the aforementioned schools consider involvement of ganglion cells or mesodermal tissue as primary in the destructive process.

MATERIAL

For the purpose of this study, material was selected from cases presenting various grades of anemias and changes in the spinal cord such as occur in pernicious anemia, secondary anemia due to leukemias, malignancies, Hodgkin's disease, lymphosarcomas and secondary anemias due to tuberculosis.

The selection of these cases was based on the fact that they belonged either to the pernicious anemia group or to the secondary anemia group in which the red blood cell count was about 3,500,000 or less, and the hemoglobin content was not higher than 75 per cent. The data for these cases are given in tables 1, 2, 3, 4, 5, 6 and 7. These tables give the blood picture, the gastric contents, the clinical neurologic observations and the changes in the spinal cord. The main object of this work was to find out whether cases of secondary anemia show the same changes in the cord as do cases of subacute combined degeneration.

In discussing these cases, it was thought advisable to follow closely the classification of Morawitz and Denecke. Cases which did not come under our observation are discussed briefly.

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5. Wohlwill, F.: Zum Kapitel der pathologisch-anatomischen Veraenderungen des Gehirn und Rueckenmarks bei pernizioeser Anaemie und verwandten Affektionen, Deutsche Ztschr. f. Nervenh. **68-69**:438, 1921.

6. Shimazono, J.: Ueber das Verhalten der zentralen und der peripheren Nervensubstanz bei verschiedenener Vergiftungen und Ernährungstörungen, Arch. f. Psychiat. **53**:972, 1914.

7. Spielmeyer, W.: Pseudosystemerkrankungen des Rueckenmarks nach Stovain-anaesthesie, Neurol. Centralbl., 1909, pt. 69.

8. Henneberg (footnote 1, first reference).

9. Hassin: Histopathological Findings in Two Cases of Subacute Combined Degeneration, M. Rec. **91**:885, 1917.

10. Globus, J. H., and Strauss, I.: Progressive Funicular Myelopathy, Arch. Neurol. & Psychiat. **8**:366 (Oct.) 1922.

TABLE 1.—*Pernicious Anemia*

No.	Sex	Age	Duration of Illness	Blood Picture: Hemoglobin	Blood Picture: Red Cells	Blood Picture: Color Index	Blood Picture: White Cells	Blood Picture: Differential Count	Gastric Analysis	Clinical Neurologic Signs	Changes in the Spinal Cord	Comment
1	M	46	8 mo.	37	1,632,000	1.13	6,000	Picture of typical pernicious anemia	Not done	+	+	
2	F	48	3 yr.	35	1,370,000	1.28	5,200	Picture of typical pernicious anemia	Achlorhydria	+	+	
3	F	45	3 yr.	44	1,400,000	1.57	3,200	Picture of typical pernicious anemia	Achlorhydria	+	—	The only case not showing changes in spinal cord
4	F	65	3 yr.	40	1,450,000	1.38	5,900	Picture of typical pernicious anemia	Achlorhydria	+	+	
5	F	50	4 yr.	68	2,610,000	1.30	7,300	Picture of typical pernicious anemia	Achlorhydria	+	+	
6	F	42	5 yr.	30	1,112,000	1.34	12,500	Picture of typical pernicious anemia	Achlorhydria	+	+	
7	M	42	5 yr.	48	2,100,000	1.14	7,200	Picture of typical pernicious anemia	Achlorhydria	+	+	
8	M	40	5½ yr.	38	1,500,000	1.27	4,000	Picture of typical pernicious anemia	Not done	+	+	
9	M	43	6 yr.	29	929,000	1.56	8,300	Picture of typical pernicious anemia	Not done	+	+	
10	M	41	7 yr.	30	700,000	2.14	7,000	Picture of typical pernicious anemia	Achlorhydria	+	+	Originally the condition in this case was diagnosed tabes dorsalis

TABLE 2.—*Carcinomas of the Stomach with Secondary Anemias*

No.	Sex	Age	Duration of Illness	Blood Picture: Hemoglobin	Blood Picture: Red Cells	Blood Picture: Color Index	Blood Picture: White Cells	Blood Picture: Differential Count	Gastric Analysis	Clinical Neurologic Signs	Changes in the Spinal Cord	Anatomic Diagnosis	Comment
1	M	50	8 mo.	50	2,272,000	1.10	22,800	Normal	Absent free HCl	.....	..	Carcinoma of the stomach	
2	M	59	1 yr.	40	3,200,000	0.62	5,200	Normal	Absent free HCl	Funicular myelitis	..	Carcinoma of the stomach	Brain and cord not removed
3	M	46	2 yr.	25	2,370,000	0.53	16,700	Normal with the exception of anisocytosis and microcytes	Absent free HCl	.....	..	Carcinoma of the stomach	
4	M	68	3 yr.	30	2,300,000	0.65	11,000	Normal	Absent free HCl	.....	..	Carcinoma of the stomach	
5	F	52	4 yr.	80	3,480,000	1.15	6,350	.....	Absent free HCl	.....	..	Carcinoma of the stomach	
6	F	52	4 yr.	58	2,800,000	1.03	5,100	.....	Absent free HCl	.....	..	Carcinoma of the stomach	
7	M	..	4 yr.	86	3,064,000	1.43	5,950	Normal with the exception of anisocytosis and poikilocytosis	Absent free HCl	Hemiplegia cerebral arteriosclerosis	..	Carcinoma of the stomach	

TABLE 3.—*Various Types of Malignancies with Secondary Anemias*

No.	Sex	Age	Duration of Illness	Blood Picture: Hemoglobin	Blood Picture: Red Cells	Blood Picture: Color Index	Blood Picture: White Cells	Blood Picture: Differential Count	Gastric Analysis	Clinical Neurologic Signs	Changes in the Spinal Cord	Anatomic Diagnosis
1	M	54	4 mo.	70	3,600,000	0.97	4,400	Normal	.....	.....	.....	Carcinoma of pancreas
2	F	52	1 yr.	60	2,320,000	1.29	11,000	Normal	.....	.....	.....	Carcinoma of thyroid
3	M	70	1 yr.	50	3,000,000	0.83	12,400	Normal with exception of 3% myeloblasts	Absent free HCl	Spinal cord tumor	Spinal cord tumor	Carcinoma of prostate
4	F	37	1 yr.	70	3,600,000	0.99	5,000	Normal	.....	.....	.....	Carcinoma of breast
5	F	51	1 yr.	70	3,220,000	1.08	9,650	Normal	.....	Transverse myelitis	Degeneration of posterior columns	Carcinoma of thyroid
6	F	52	1 yr.	80	3,480,000	1.15	6,350	Normal	.....	.....	.....	Carcinoma of bile passages
7	F	59	1 yr.	60	2,800,000	1.07	7,800	Normal	Absent free HCl	.....	.....	Carcinoma of thyroid
8	M	44	1 yr.	30	1,800,000	0.83	20,000	Normal	.....	.....	.....	Hypernephroma
9	F	54	1½ yr.	History stated that patient was markedly cachectic; blood count could not be found					.....	Metastatic carcinoma of the spine	Degeneration of posterior columns	Carcinoma of breast
10	M	50	2 yr.	55	2,000,000	1.37	10,000	Normal	.....	.....	.....	Carcinoma of gallbladder
11	M	65	2 yr.	50	3,400,000	0.74	7,200	Normal	.....	.....	.....	Carcinoma of rectum
12	F	18	2½ yr.	52	2,800,000	0.86	14,400	Normal	.....	Extramedullary neoplasm	.....	Small cell sarcoma of lumbar region
13	F	35	7 yr.	65	3,520,000	0.92	.....	.....	.....	Multiple sclerosis	Multiple sclerosis	Carcinoma of breast
14	M	40	8 yr.	25	1,300,000	0.96	2,900	Normal	Absent free HCl	Combined sclerosis	Transverse myelitis	Retroperitoneal sarcoma

TABLE 4.—*Hodgkin's Disease with Secondary Anemia*

No.	Sex	Age	Duration of Illness	Blood Picture: Hemoglobin	Blood Picture: Red Cells	Blood Picture: Color Index	Blood Picture: White Cells	Blood Picture: Differential Count	Clinical Neurologic Signs	Changes in the Spinal Cord	Anatomic Diagnosis	Comment
1	M	46	3 yr.	70	3,500,000	1.00	4,700	Normal	Weakness of legs and stiffness of gait	.....	.....	Under deep roentgen therapy the neurologic signs disappeared
2	M	47	3 yr.	75	3,600,000	1.04	11,600	Normal	Compression of cord transverse myelitis	Autopsy not performed		
3	F	27	3 yr.	75	3,460,000	0.92	14,200	Normal	None	Plaque of degeneration of the medulla involving the pyramidal tract	.....	X-ray picture of tenth rib showed an egg-shaped enlargement of the spine
4	M	70	6 yr.	65	3,800,000	0.84	11,800	Normal	None	Cord not removed		
5	M	22	6 yr.	28	1,500,000	0.93	3,600	Normal	Posterolateral sclerosis	Slight involvement of Goll's column	.....	Patient had a tuberculous meningitis
6	F	34	8 yr.	63	3,240,000	0.92	7,800	Normal	Combined degeneration	Involvement of both lateral pyramidal tracts	Retroperitoneal Hodkgin's disease	

TABLE 5.—*Lymphosarcomas with Secondary Anemias*

No.	Sex	Age	Duration of Illness	Blood Picture: Hemoglobin	Blood Picture: Red Cells	Blood Picture: Color Index	Blood Picture: White Cells	Blood Picture: Differential Count	Clinical Neurologic Signs	Changes in the Spinal Cord	Anatomic Diagnosis	Comment
1	F	61	6 mo.	70	3,600,000	0.97	8,800	Normal	Paraplegia; transverse myelitis	Compression myelitis	Lymphosarcoma	Mass found opposite upper lumbar segments
2	M	32	9 mo.	90	3,520,000	1.29	6,200	Normal	Combined sclerosis	Involvement of posterior columns only	Lymphosarcoma	Picture as in tabes dorsalis
3	M	40	1½ yr.	History stated that patient was cachectic; records of blood count could not be found					Posterior column disease	None		

TABLE 6.—*Tuberculosis with Secondary Anemias*

No.	Sex	Age	Duration of Illness	Blood Picture: Hemoglobin	Blood Picture: Red Cells	Blood Picture: Color Index	Blood Picture: White Cells	Blood Picture: Differential Count	Gastric Analysis	Clinical Neurologic Signs	Changes in the Spinal Cord	Anatomic Diagnosis	Comment
1	M	22	7 wk.	65	3,850,000	0.84	9,600	Normal	Not done	Tuberculous meningitis	..	Miliary tuberculosis; tuberculous meningitis	
2	M	45	1 yr.	65	3,448,000	0.95	7,200	Normal	Not done	Myotonia atrophica	..	Pulmonary tuberculosis; endothelioma of brain	Endothelioma involving temporal lobe
3	M	37	1½ yr.	60	3,200,000	0.95	8,400	Normal	Not done	.....	..	Pulmonary tuberculosis	
4	M	62	2 yr.	70	3,800,000	0.94	8,400	Normal with one nucleated red cell	Not done	Huntington's chorea	..	Pulmonary tuberculosis	Huntington's chorea
5	M	55	3½ yr.	50	2,750,000	0.90	6,800	Normal	Not done	.....	..	Pulmonary tuberculosis; chronic lymphatic leukemia	
6	F	75	10 yr.	70	3,920,000	0.90	7,800	Normal	Not done	.....	..	Pulmonary tuberculosis	

TABLE 7.—*Leukemias*

No.	Sex	Age	Duration of Illness	Blood Picture: Hemoglobin	Blood Picture: Red Cells	Blood Picture: Color Index	Blood Picture: White Cells	Blood Picture: Differential Count, per Cent	Gastric Analysis	Clinical Neurologic Signs	Changes in the Spinal Cord	Anatomic Diagnosis	Comment
1	M	30	1 yr. 3 mo.	34	2,200,000	0.77	208,000	Polymorphonuclears 21 Large lymphocytes 50 Myeloblasts 17 Small lymphocytes 10 Transitionals 2 Anisocytosis and poikilocytosis	Negative	None	None	Chronic myelocytic leukemia	
2	M	69	1½ yr.	15	760,000	0.79	102,000	Polymorphonuclears 10 Lymphocytes 88 Eosinophils 2	Negative	None	None	Chronic lymphatic leukemia	
3	M	66	2½ yr.	32	2,450,000	0.66	113,000	Polymorphonuclears 0.5 Small lymphocytes 99.5	Not done	None	None	Chronic lymphatic leukemia	
4	M	55	10 yr.	50	2,750,000	0.90	4,900	Polymorphonuclears 59 Small lymphocytes 32 Large lymphocytes 5 Eosinophils and basophils 4	Negative	None	None	Chronic lymphatic leukemia	This blood count was made following deep roentgen therapy

ANEMIAS CAUSED BY ABNORMALLY INCREASED LOSS OF RED BLOOD CELLS

The acute posthemorrhagic anemias, following severe trauma, may be overlooked for they do not produce any lasting changes in the spinal cord.

The cases of chronic posthemorrhagic anemias are due to disease causing hemorrhages of the mucous membranes of the gastro-intestinal tract, menorrhagia, etc., or are produced by certain worms such as *Ankylostoma duodenale* and *Bilharzia haematobia*. (*Bothriocephalus latus* does not belong in this group.) According to the literature and to clinical experience, there are no cases of ulcers of the stomach or of the duodenum which produce the clinical or microscopic picture of subacute combined degeneration, though the anemia in this type of case may have been pronounced and of long duration. The rapid recovery of patients suffering from infestation with *Ankylostoma duodenale* with severe anemia after the removal of the worms, even after long duration of the disease, speaks in itself against any combined degeneration of the central nervous system. It may be added that animal experimentation with repeated hemorrhages failed to produce changes in the spinal cord.[11]

The same may be said of attempts to produce subacute combined degeneration in animals with hemolytic chemicals such as pyridine pyrogallol, glycerin and toluylendiamine. In lead poisoning, the lesions of the spinal cord, if any, were mostly those of secondary degeneration of the posterior columns, following degenerative changes in the posterior roots and lesions of the peripheral nerves.

Combined degeneration produced by *Bothriocephalus latus* was described in 1887 by Minnich and Lichtheim.[12] The blood picture in many of these cases resembled that of Addison's pernicious anemia. More recent investigations point to an endotoxin as the cause of the disease. It is liberated when the worm dies. An attempt to obtain this toxin led to the isolation of the cholesterol ester of the oleinic acid. Faust and Tallquist,[13] experimenting with this substance, produced a moderate reduction of the number of the red blood cells without inducing pernicious anemia. The blood picture of Addison's anemia in infestation by *Taenia saginata* was described by Nonne and Eisenlohr,[14]

11. Voss: Anatomische und experimentelle Untersuchungen über die Rückenmarks Veränderungen bei Anemia, Deutsches Arch. f. klin. Med., vol. 58, p. 389.

12. Minnich and Lichtheim, cited by Henneberg (footnote 1, first reference, p. 771).

13. Faust and Tallquist: Ueber die Ursachen der Botriocephalus Anämie: Ein Beitrag zur Pathogenese der perniziösen Anämie auf physiologischchemischer Grundlag, Arch. f. exper. Path. u. Pharmakol. **57**:367, 1907.

14. Nonne and Eisenlohr, cited by Morawitz and Denecke (footnote 2, p. 115).

Naegeli and Reckzeh.[15] The blood picture returned to normal after the removal of the worms.

Chronic hemolytic icterus does not produce subacute combined degeneration of the spinal cord. It is well known that though the anemia accompanies these patients during their whole life, they never complain of any severe disturbances as a sequence of the hereditary icterus which might cause them to seek medical aid.

The hemolytic anemias of the puerperium, which present the pernicious type of blood picture as in Addison's disease, are completely cured after delivery. In malaria, subacute combined degeneration does not seem to occur primarily. Reports of such cases could not be found in the recent literature. Considering the frequency of this disease, changes in the spinal cord should have been observed. Henneberg cited a case of his own and mentioned two examples of Mayer and Oppenheim.[16] These authors did not state whether the pernicious type of anemia was present in these cases. Secondary anemia is the rule in this disease. Morawitz never noticed Addison's anemia in malaria. A blood picture resembling that in Addison's anemia was described as present in sprue. Weiss, in his recent review, however, pointed out that the anemia was secondary to a gastro-intestinal lesion, and that selective pathologic changes of the central nervous system had not been found.[17]

PROGRESSIVE PERNICIOUS ANEMIA

The classic disease for the study of subacute combined degeneration is Addison's (pernicious) anemia. Ten cases of this disease were studied from our own material (table 1). All of the cases presented a typical blood picture of pernicious anemia. Seven showed achlorhydria, and in the three cases without achlorhydria, records of gastric analyses could not be found. All of these cases showed clinical neurologic observations and all came to autopsy. Nine of the cases showed histologically a definite picture of subacute combined degeneration. Case 3 did not present any marked changes in the spinal cord, but showed only slight thickening of the adventitia of the blood vessels, although clinically the neurologic symptoms pointed to posterior and anterior root involvement. The question is open for discussion whether in this case the primary changes did not occur in the peripheral nerves as in similar cases reported by von Bogaert.[18]

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15. Naegeli and Reckzeh, cited by Morawitz and Denecke (footnote 2, p. 115).

16. Mayer, K., and Oppenheim, cited by Henneberg (footnote 1, first reference).

17. Weiss, C.: Recent Literature on Tropical Sprue, Arch. Path. **6**:885 (Nov.) 1928.

18. Von Bogaert, L.: La polynévrite anémique, Ann. de méd. **22**:321, 1927.

The number of cases showing clinical neurologic signs in this series conforms to Woltman's,[19] who, in an analysis of 150 cases, found that 80 per cent showed clinical neurologic pictures. Wilson and F. A. Evans,[20] in an analysis of 111 cases, found that 74 per cent presented neurologic signs. Minnich [21] found clinical neurologic manifestations in 77 per cent of his cases.

The achlorhydria was a predominating sign, being present in practically all the cases except three in which the gastric analysis was not done. According to Hurst,[22] free hydrochloric acid is invariably absent throughout the entire period of digestion. The achlorhydria precedes the anemia and is present throughout all stages of the disease; it is the most constant symptom. The changes in the spinal cord may precede the changes in the blood picture, but always follow the achlorhydria. In other conditions, such as carcinoma of the stomach, it is not at all uncommon to find a small quantity of free hydrochloric acid.

The microscopic picture has been so often and so thoroughly described that not much of importance can be added. In case 1 (fig. 1), in which the disease process lasted eight months, the destructive changes affected mainly the dorsal segments. In comparing myelin sheath stains with Bielschowsky stained sections (figs. 4 and 5) of the same block, the destructive process was seen to affect both myelin sheaths and axis cylinder alike. Stains for glia fibers (Anderson's modification of the Victoria blue method, fig. 3) gave a clearly defined picture of the status spongiosus, which was best shown in the posterior columns and in beginning stages in the lateral columns. In the upper cervical regions the same staining methods revealed only secondary ascending degeneration of the posterior columns without the development of "Lückenfeldern." It was only in the cases of three years' duration that the destructive process was seen in the cervical and lumbar segments. It seems of interest to point out the action of the fibrous glia in relation to other degenerative processes of the spinal cord. Spielmeyer [23] empha-

19. Woltman, H. W.: The Nervous System in Pernicious Anemia: An Analysis of 150 Cases, Collected Papers by the Mayo Clinic, **10**:933, 1918.

20. Wilson, C. R., and Evans, F. A.: Analysis of Clinical Histories of Patients with Pernicious Anemia in Johns Hopkins Hospital, 1918-1922, Bull. Johns Hopkins Hosp. **35**:38, 1924.

21. Minnich, W.: Zur Kentniss der in Verlauf der perniziösen Anämie-beobachteten Spinalerkrankungen, Ztschr. f. klin. Med. **21**:25, 1893.

22. Hurst, A. F.: The Pathogenesis of Subacute Combined Degeneration of the Spinal Cord with Special Reference to Its Connection with Addison's Pernicious Anemia, Achlorhydria and Intestinal Infection, Brain **48**:212 (Jan.) 1925; Addison's Anemia with Subacute Combined Degeneration of the Spinal Cord, Brit. M. J. **1**:93, 1924.

23. Spielmeyer, W.: Histopathologie des Nervensystems, Berlin, Julius Springer, 1922, vol. 1.

sized the difference in action of the fibrous glia in secondary degenerations from that in the foci of funicular myelitis. While in the first case in longitudinal sections stained with Weigert's glia stain is shown a dense field of parallel glia fibers with finer fibers running transversely which follow in their course the original arrangement of the nervous substance, the picture is different in the second instance. In our case of eight months' duration, the status spongiosus is well defined in Victoria blue-stained sections (fig. 3). The Lückenfeldern are encircled by coarse glia fibers, but these areas are not yet organized. For com-

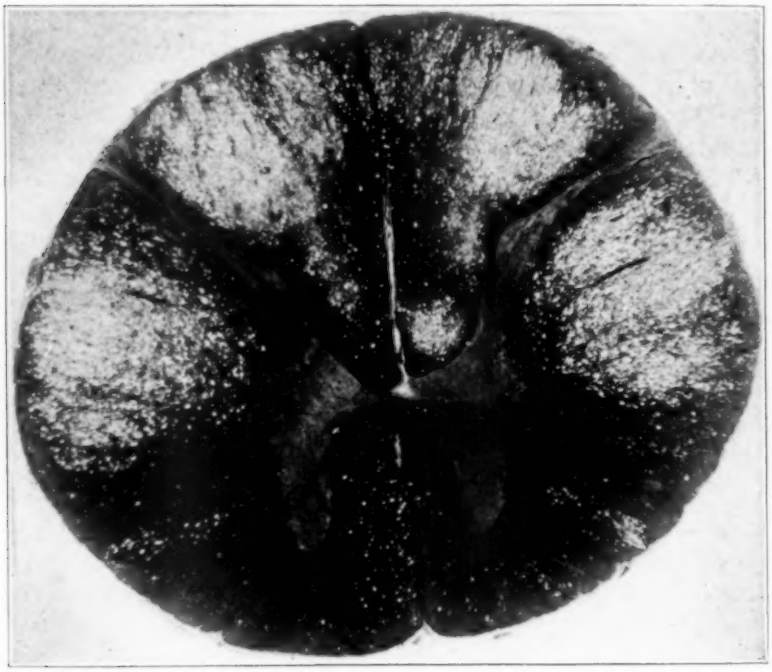

Fig. 1 (case 1, table 1).—Transverse section of middorsal segment, showing degeneration of the posterior and lateral columns with Lückenfeldern in pernicious anemia of eight months' duration. Weil stain; × 30.

parative studies, longitudinal sections through the posterior columns of middorsal segments stained with Anderson's Victoria blue method from other cases of degenerative diseases of the spinal cord were studied. In cases of Addison's anemia of five years' duration (Figs. 6, 7, 8, 9), the arrangement of the Lückenfeldern was still visible; not much progress of fibrous organization of these areas could be noticed in comparison with the case of eight months' duration. In a case of secondary degeneration of Goll's columns in a chordoma (fig. 10) of the lumbar region the isomorphous gliosis was well developed after one year and a half,

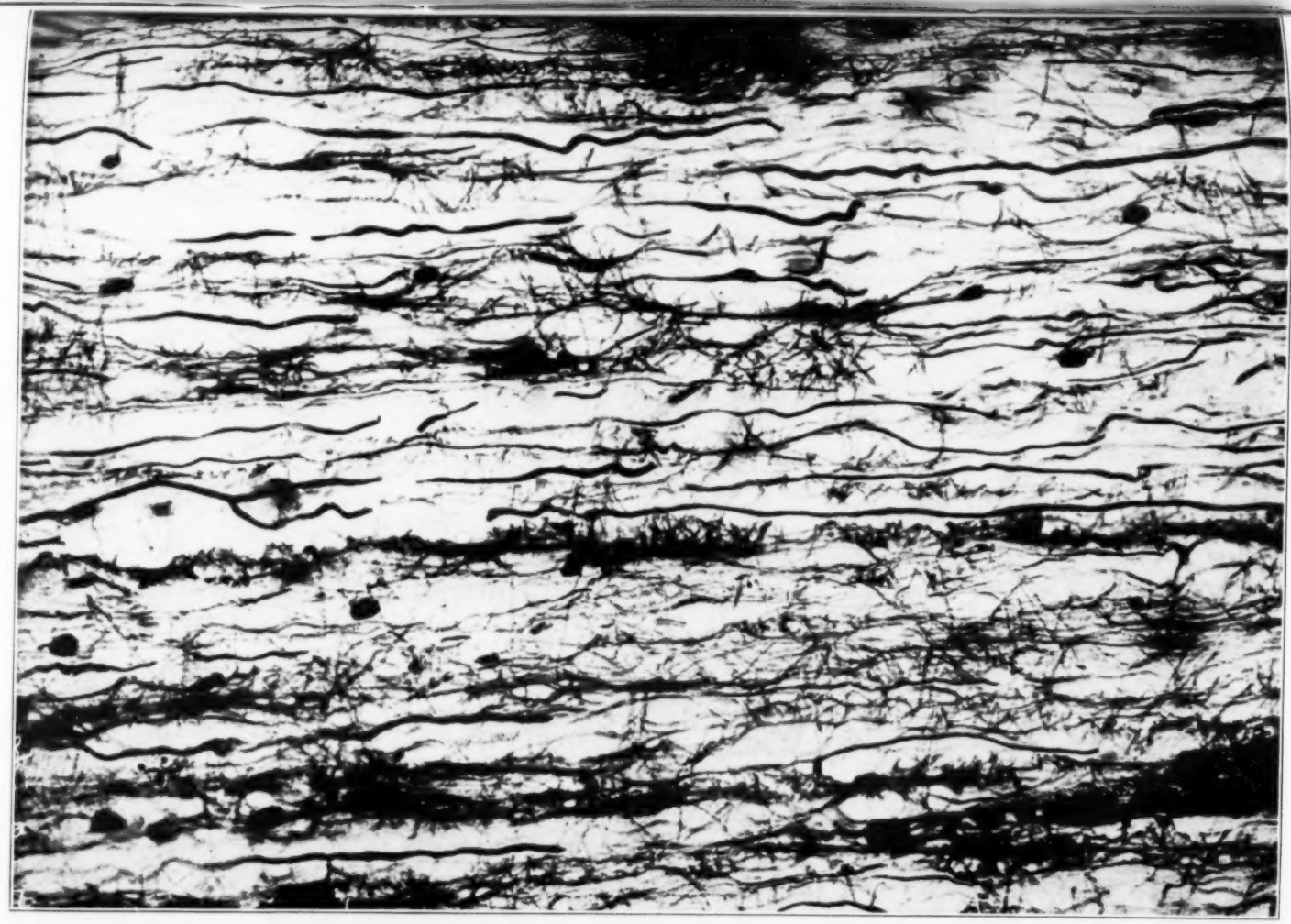

Fig. 2.—Longitudinal section through the posterior columns, middorsal segment of normal spinal cord. Victoria blue stain, Anderson's modification; × 400. Compare this normal section with the other longitudinal sections stained by the same method.

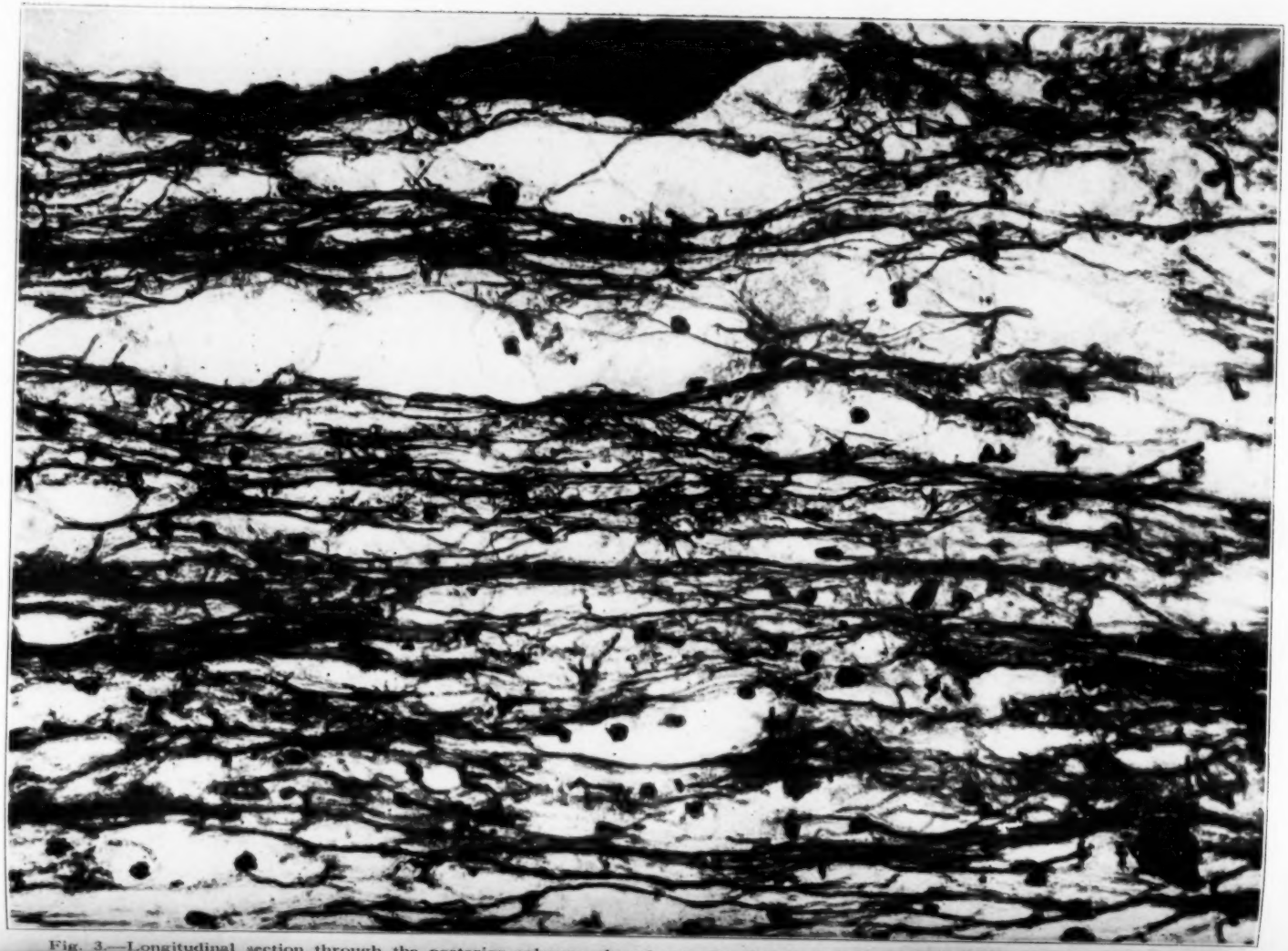

Fig. 3.—Longitudinal section through the posterior columns, dorsal segment, showing "status spongiosus" in pernicious anæmia of eight

Fig. 3.—Longitudinal section through the posterior columns, dorsal segment, showing "status spongiosus" in pernicious anemia of eight months' duration. Victoria blue stain.

Fig. 4.—Same as figure 3, showing destruction of myelin sheaths and parallel arrangement of the glia fibers. Weil stain; × 400.

Fig. 5.—Same as figure 3.—Richardson's stain; × 400.

and the same picture was seen in secondary degeneration of the pyramidal tract following a lesion of the internal capsule after two and one half years' duration. Similar pictures were produced in amyotrophic lateral sclerosis. In tabes dorsalis (fig. 11) and in multiple sclerosis (fig. 12) the condensation of longitudinal fibers is much more marked.

It is of interest to point out the state of the axis cylinders in case 1, of pernicious anemia, which was of eight months' duration. In this case, in the area of degeneration a few axis cylinders are still left (fig. 5). In the case of pernicious anemia of five years' duration (figs.

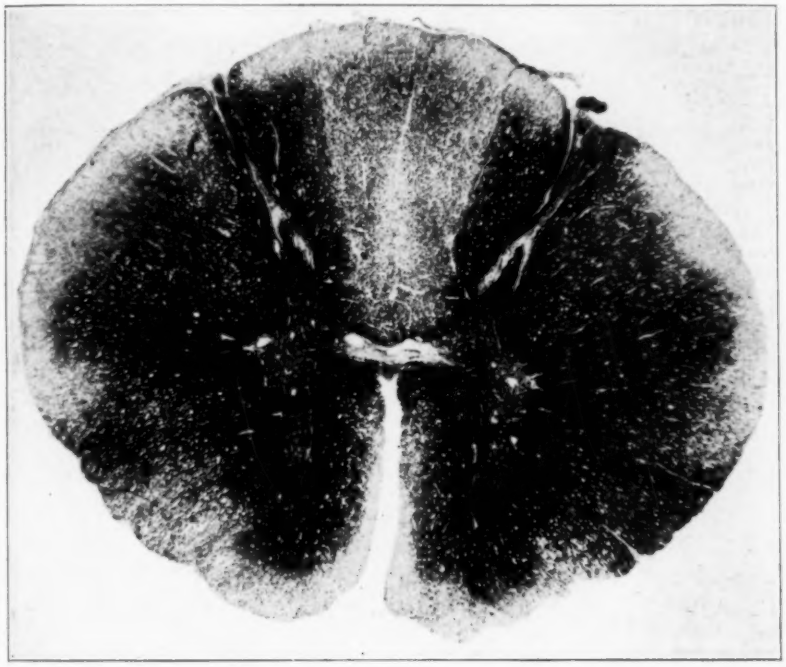

Fig. 6 (case 7, table 1).—Transverse section of middorsal segment, showing degeneration of the posterolateral columns in pernicious anemia of five years' duration. At low magnification the degenerated areas present a more homogeneous appearance as compared with figure 1. Weil stain; × 30.

8 and 9) there are no well preserved axis cylinders. The case of multiple sclerosis of nineteen years' duration shows the axis cylinders better preserved than in any of the aforementioned conditions.

The different action of the fibrous glia in old foci of pernicious anemia, together with the rest of the histologic picture, is not in favor of the theories which consider subacute combined degeneration merely as a primary process of demyelinization, thus placing it in the group of pathologic changes described in multiple sclerosis. It seems that the

hypothetical toxin not only acts destructively on the myelin sheath and axis cylinder, but at the same time inhibits the organizing function of the fibrous glia. As there is no dense glial scar formation, the term "combined sclerosis" should be abandoned.

The fact that combined degeneration of the spinal cord is sometimes found without the blood picture of Addison's anemia has led to theories which regard it as a separate disease entity. Investigations on large clinical and autopsy material, however, have proved that though the changes in the spinal cord may precede the anemia, the changes in the blood picture may be observed if these cases remain under constant observation.[24] According to Reese and Beigler,[25] the prognosis in pernicious anemia presenting changes in the spinal cord without a typical blood picture is not good.

ANEMIAS DUE TO DECREASED FORMATION OF RED BLOOD CELLS

HYPOPLASTIC ANEMIAS ASSOCIATED WITH CACHEXIA, INANITION

It is not unusual to find clinical neurologic symptoms in secondary anemias due to tumors that suggest a picture of subacute combined degeneration. With this in view, a series of thirty cases of different types of tumors with secondary anemias in which histologic examination of the spinal cord could be done (with few exceptions) were selected for study. Of these cases seven were cases of carcinoma of the stomach; fourteen, different types of malignancies; six, Hodgkin's disease, and three, lymphosarcoma. These are grouped in tables 3, 4, 5 and 6.

Carcinomas of the Stomach.—Carcinomas of the stomach are always cited as proving the occurrence of subacute combined degeneration of the spinal cord in anemias other than Addison's.

In reviewing the more recent literature on this subject, one finds that those cases of cancer of the stomach which showed changes in the spinal cord besides the achlorhydria at the same time showed also the blood picture of pernicious anemia and not that of secondary anemia. Such examples are the cases of Waterfield,[26] Garvey and Stern,[27] Son-

24. Lauterbach, A.: Ueber die Beziehung der kombinierten Strangerkrankung zur perniziösen Anämie, Ztschr. f. d. ges. Neurol. u. Psychiat. **95**:1, 1925.

25. Reese, H., and Beigler, S. K.: Subacute Combined Degeneration of the Spinal Cord and Pernicious Anemia, Am. J. M. Sc. **171**:194, 1926.

26. Waterfield, R. L.: Subacute Combined Degeneration of the Spinal Cord with Achylia Gastrica Caused by Atrophic Gastritis, Guy's Hosp. Rep. **77**:93, 1923; Addison's Anemia with Subacute Combined Degeneration of the Spinal Cord, Secondary to Cancer of the Stomach, Guy's Hosp. Rep. **73**:208, 1923.

27. Garvey and Stern: Combined Sclerosis of Spinal Cord and Carcinoma of the Stomach, Am. J. M. Sc. **68**:847, 1922.

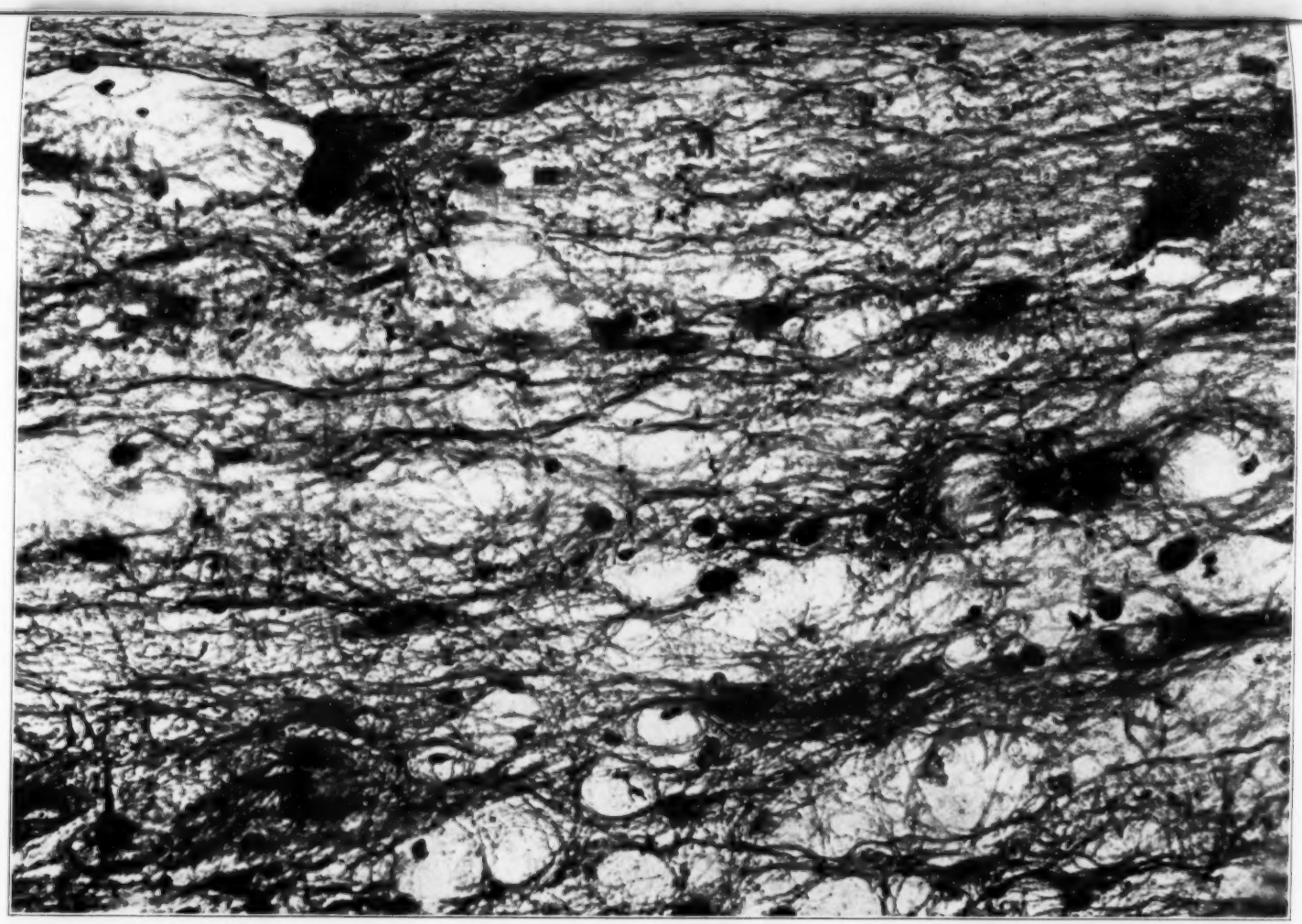

Fig. 7 (case 7, table 1).—Longitudinal section through the posterior columns, dorsal segment in pernicious anemia of five years' duration. Victoria blue stain; × 400.

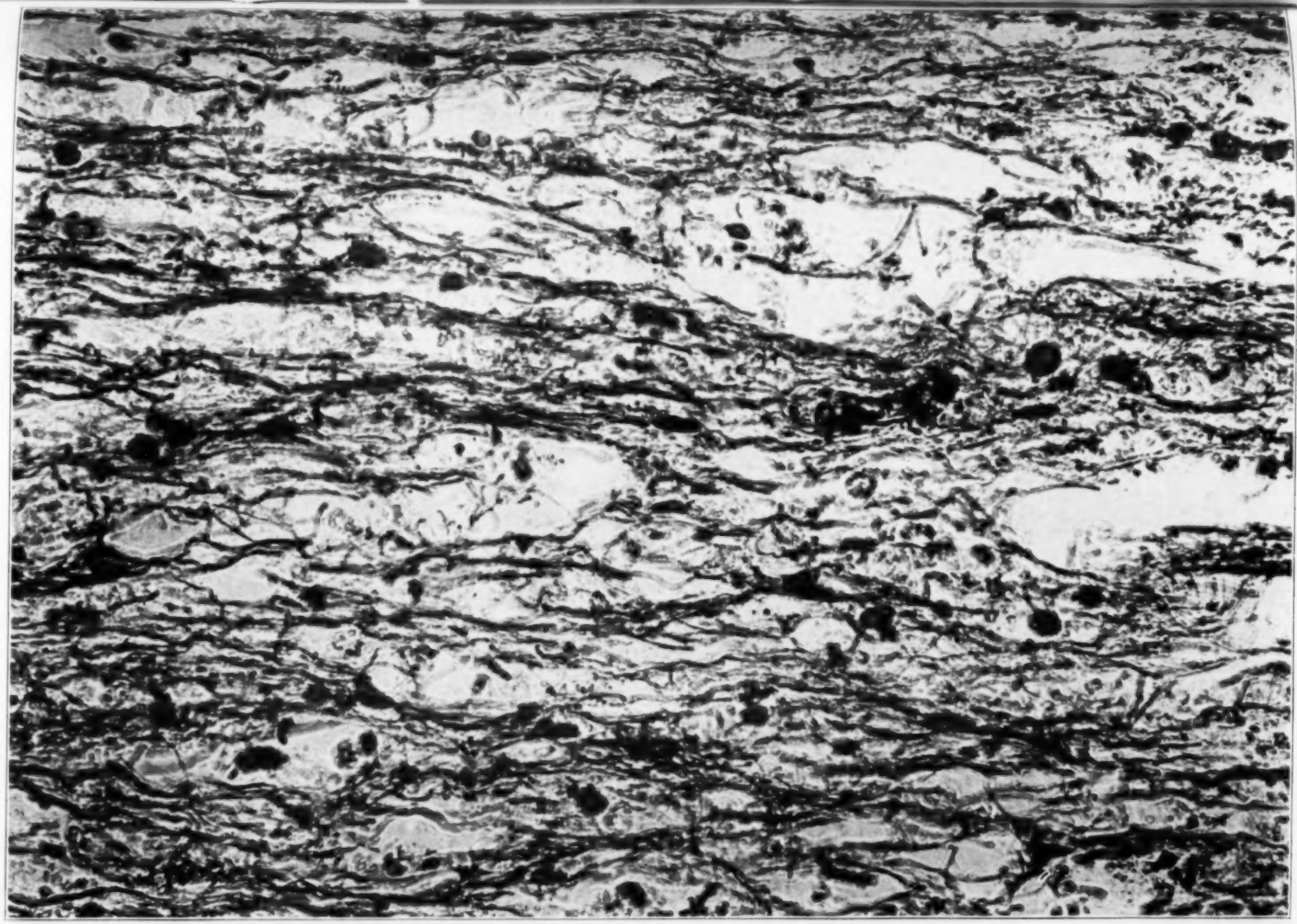

Fig. 9.—Same as figure 7. Cajal stain; × 400.

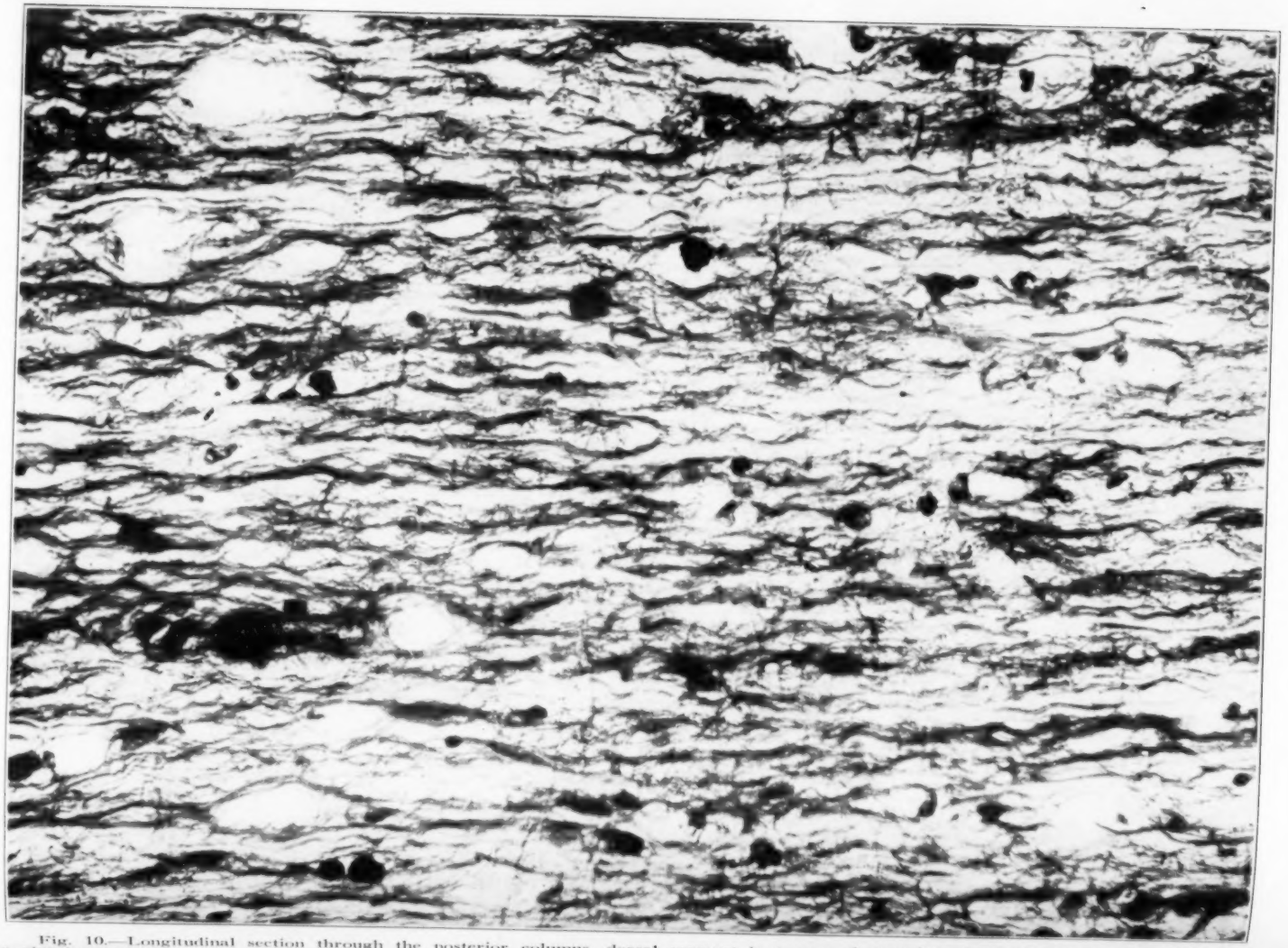

Fig. 10.—Longitudinal section through the posterior columns, dorsal segment in a case of secondary ascending degeneration following

nenfeld [28] and Hurst.[29] Bertrand and Ferraro [30] had an interesting case of carcinoma of the stomach with definite changes in the spinal cord simulating subacute combined degeneration. The red blood cell count in this case was 2,400,000; hemoglobin, 85 per cent; color index, 1.77. A differential count was not done in this case. We believe that this case falls in the group of cases of carcinoma of the stomach with a coexistent pernicious anemia. Hurst [29] pointed out that the achlorhydria found in Addison's anemia exists throughout the entire period of digestion, while in cancer of the stomach it is not uncommon to find a small quantity of free hydrochloric acid. The fact that achlorhydria in itself does not produce subacute combined degeneration is proved by his observation that 4 per cent of normal persons have constitutional achylia gastrica.

In our material of seven cases of carcinoma of the stomach, with the exception of case 2, none showed neurologic signs of subacute combined degeneration of the spinal cord in spite of a constant achlorhydria, a high color index and a duration of the disease of from one to four years (table 2).

Case 2, in which there was a clearcut clinical picture of funicular myelitis and carcinoma of the stomach, came to autopsy, but we were not fortunate in securing the brain and spinal cord.

Of 189 cases of cancers of the stomach that were under clinical observation at this hospital from 1922 to 1928, 20 showed a secondary anemia, and only 2 were found which suggested a neurologic syndrome of subacute combined degeneration.

One of us (A.W.), with Kraus,[31] proved that in cases of cancer combined with severe cachexia and secondary anemia no case of subacute combined degeneration was found. If there were any funicular degenerations, they could be traced back to metastases in the vertebrae or the meninges, producing ascending degeneration of the posterior columns as a sequence of lesions of the posterior root. The theory of a cancer toxin invading the spinal cord and producing destructive changes could not be proved (tables 2 and 3 prove this statement).

In view of these observations, one is more inclined to accept the opinions of Naegeli,[32] who claimed that a combination of cancer of the

28. Sonnenfeld, A.: Perniziöse Anämie und Carzinom, Deutsche med. Wchnschr. **50**:1794, 1924.

29. Hurst (footnote 22, first reference).

30. Bertrand, I., and Ferraro, A.: Contributo alla conoscenza dell' anatomia patrologica della degeneratione subacuta combinata del midollospinalle, II Cervelo, 1924, vol. 3, no. 1, p. 126.

31. Weil, A., and Kraus, W. M.: Cancer and the Spinal Cord, Am. J. M. Sc. **171**:825, 1926.

32. Naegeli: Blutkrankheiten und Blutdiagnostik, ed. 4, Leipzig, 1923.

Fig. 10.—Longitudinal section through the posterior columns, dorsal segment in a case of secondary ascending degeneration following

stomach with Addison's anemia is accidental. Brandes,[33] however, tried to rule out accidental occurrences and considered this as a causative connection.

Other Types of Malignant Disease.—Fourteen cases of this group were selected. All of these showed a secondary anemia. Cases 3, 5, 9, 12, 13 and 14 showed changes in the spinal cord (table 3). All of these cases showed neurologic signs and involvement of the spinal cord. Case 3 was one of carcinoma of the prostate with neurologic symptoms, presenting a picture of tumor of the spinal cord; autopsy revealed compression of the cord at about the sixth dorsal level. Case 5 was one of carcinoma of the thyroid with clinical neurologic signs of a transverse myelitis; autopsy revealed a tumor at the level of the third and fourth thoracic vertebrae (fig. 13). Case 9 was a case of carcinoma of the breast with neurologic signs suggestive of a level lesion; autopsy revealed a metastasis to the cervical portion of the spine (fig. 14). Case 12 was one of osteogenetic sarcoma of the sacrum with neurologic signs suggestive of an extramedullary neoplasm. Case 13 was one of carcinoma of the breast with neurologic signs of multiple sclerosis. The cord in this case presented the same typical histologic picture of multiple sclerosis as seen in figure 12; evidently, the two conditions coexisted independently. Case 14 was a case of retroperitoneal sarcoma with clinical neurologic signs of subacute combined degeneration; at autopsy a spongy fatlike mass of about 0.5 by 1 cm. in diameter was found pressing on the spinal cord at the first lumbar vertebra. Histologic examination revealed a picture of transverse myelitis with secondary ascending and descending degeneration.

The histologic pictures of the Anderson's glia stains of the degenerated tracts in the cases cited, except in the case of multiple sclerosis, resembled those shown in figure 10.

Among fifty-six cases of malignant disease with less than 70 per cent hemoglobin and less than 3,500,000 red blood cells in which the patients were under clinical observation at Montefiore Hospital from 1922 to 1928, there were only four which suggested clinically a subacute combined degeneration of the spinal cord.

Hodgkin's Disease.—Six cases of this group were selected which showed a secondary anemia; some showed neurologic signs (table 4). Four of these cases came to autopsy.

Case 1 showed neurologic signs; on deep roentgen therapy these signs disappeared, and the patient is still living. In case 2 the condition was diagnosed as transverse myelitis due to compression of the

33. Brandes, T.: Ueber die Beziehungen der perniziösen Anämie zum Magencarcinom, Med. Klin. **17**:193, 1921.

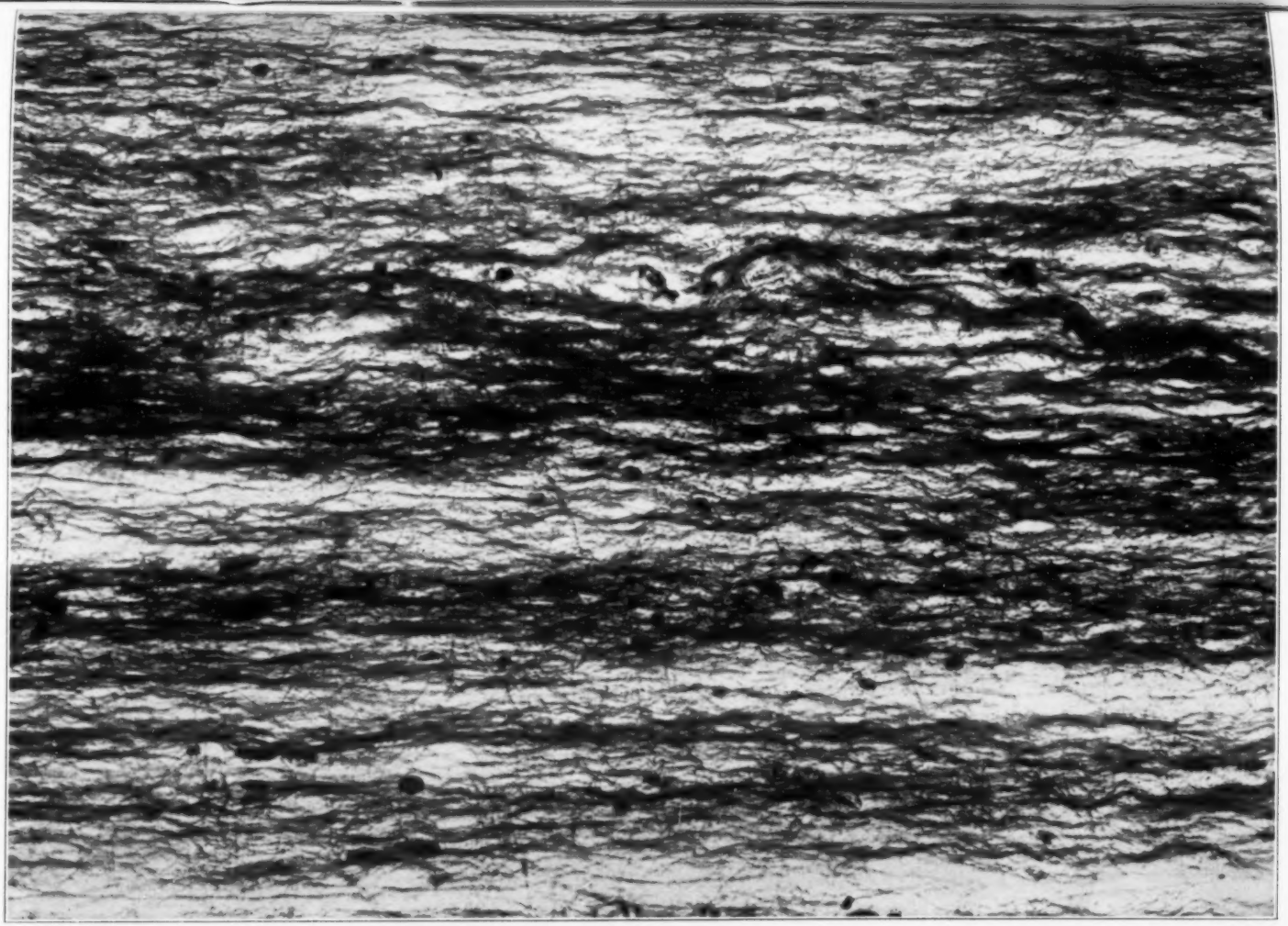

Fig. 11.—Longitudinal section through the posterior columns of the dorsal segments in a case of tabes dorsalis, showing marked condensation of the longitudinal fibers. Victoria blue stain; × 420.

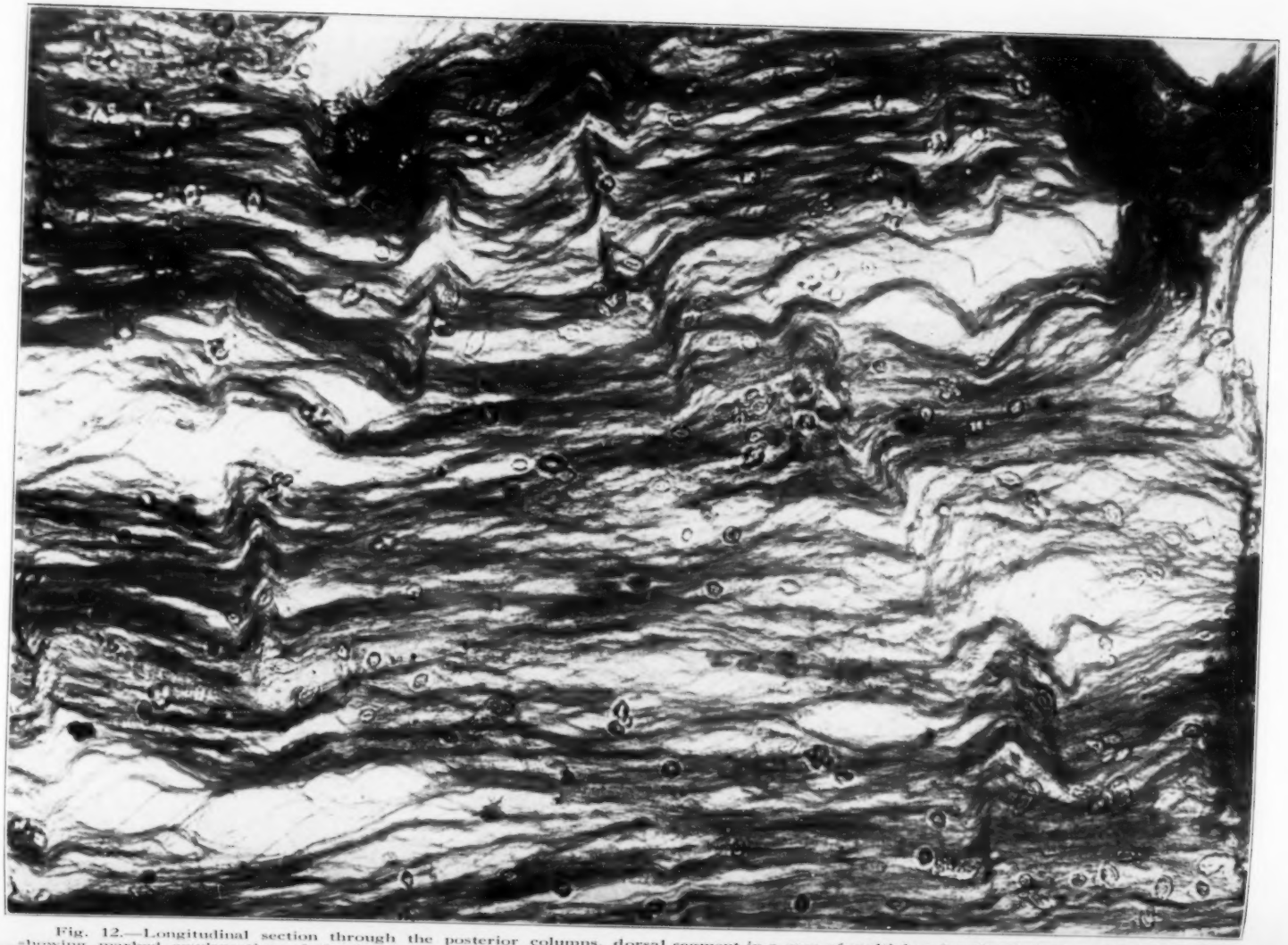

Fig. 12.—Longitudinal section through the posterior columns, dorsal segment in a case of multiple sclerosis of nineteen years' duration, showing marked condensation of the longitudinal fi

Fig. 13 (case 5, table 3).—Transverse section of spinal cord at about the fourth dorsal level, showing areas of degeneration in the lateral column. Weil stain; × 30.

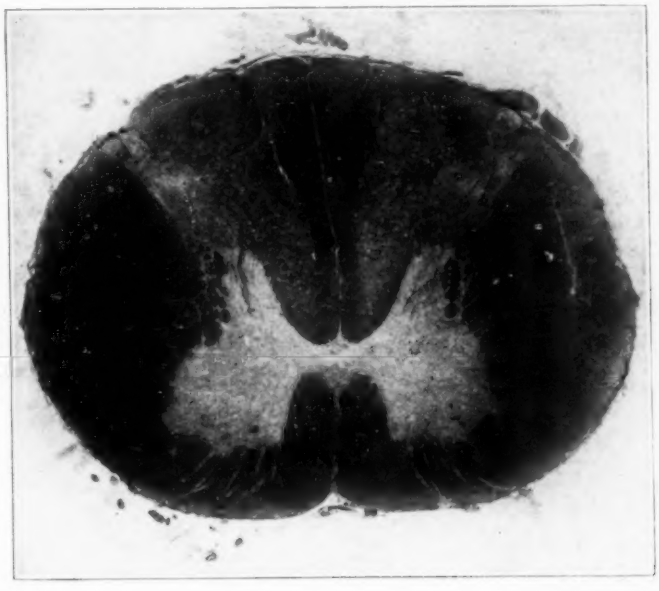

Fig. 14 (case 9, table 3).—Transverse section of spinal cord through mid-cervical segment, showing paling of columns of Burdach following compression of posterior roots. Weil stain; × 30.

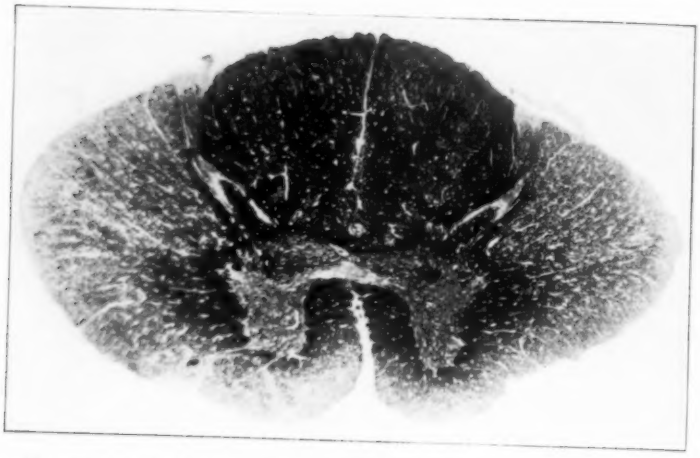

Fig. 15 (case 6, table 4).—Transverse section of spinal cord, upper dorsal segment, showing degeneration of both lateral pyramidal tracts in a case of Hodgkin's disease. Weil stain; × 30.

Fig. 16 (case 2, table 5).—Transverse section of midcervical segment, showing uniform degeneration of the posterior column. Weil stain; × 30.

cord; necropsy was not done in this case. Cases 3 and 4 did not show any neurologic signs. The patient in case 5 showed neurologic signs of posterolateral sclerosis; aside from the fact that there was a tuberculous meningitis, the cord did not show any changes in the posterior or lateral columns. Case 6 showed clinically a picture of combined degeneration; histologically, the cord showed, with Weil's stain, degeneration of both lateral pyramidal tracts (fig. 15); autopsy revealed a retroperitoneal Hodgkin's disease extending from the celiac plexus down to the pelvis and causing pressure on the nerve roots.

In Hodgkin's disease, whatever changes are found in the spinal cord seem to be due not to the secondary anemia, but to the invasion of the spinal cord causing pressure. This kind of invasion of the nervous system in Hodgkin's disease was reported by Murchison,[34] and later noted by many other observers such as Goodhart, Gowers, Osler, Sternberg and Ginsburg.[35]

Lymphosarcoma.—Three cases of lymphosarcoma presenting secondary anemia (table 5) and neurologic signs were found in our records of thirteen cases since 1922. Case 1 showed clinical signs of transverse myelitis, and at autopsy a tumor mass was found which caused compression of the upper lumbar segments. Case 2, in which the condition was diagnosed as subacute combined degeneration, showed a histologic picture of tabes dorsalis (fig. 16); the Wassermann reactions of the blood and spinal fluid in this case were negative; whether we were dealing with two separate disease entities in this case is difficult to state; the histologic picture with Anderson's glia stain resembled definitely the histologic picture in figure 11. In case 3 a record of the blood picture could not be found, but the history stated that the patient was markedly cachectic. The neurologic signs were those of disease of the posterior column; histologically, the posterior column did not show any degenerative changes.

A review of all these cases of tumor easily convinces one that whatever changes were found in the spinal cord were chiefly due to pressure and not to anemia.

Tuberculosis.—Only six of seventy-five cases of tuberculosis that came to autopsy, in which the brains and cords were removed, showed secondary anemia, not severe, with the exception of case 3 (table 6). None of these cases presented clinical pictures of subacute combined degeneration. Some of the seventy-five cases showed neurologic signs chiefly in the form of meningitis.

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34. Murchison, C.: Tr. Path. Soc. London **20**:192, 1869.

35. Ginsburg, S.: Hodgkin's Disease with Predominant Localization in the Nervous System, Arch. Int. Med. **39**:571 (April) 1927.

Lymphatic and Myelocytic Leukemias.—Changes in the spinal cord have been reported in the different forms of leukemia. Barker,[36] who made a special study of the changes in the central nervous system in leukemia, described: (1) myelitis, (2) leukemic infiltrations, (3) hemorrhages, (4) epidural foci, (5) diseases of the posterior roots and herpes zoster and (6) leukemic infiltrations of the leptomeninges. Leukemic infiltrations and hemorrhages are mostly described as changes in the spinal cord following chronic myelogenous leukemia.[37] Other degenerative changes in the form of multiple myelopathic foci may be secondary to these vascular disturbances. Henneberg [38] cited cases of Kast, Schultze and Nonne with changes "resembling those found in spinal cord diseases in anemia," but he too emphasized the frequency of the other changes already mentioned.

In our autopsy material we had four cases of lymphatic and myelocytic leukemia. None showed any clinical or pathologic manifestations of the spinal cord (table 7). Of eighteen cases that were under clinical observation at the Montefiore Hospital from 1922 to 1928, no cases could be found which showed signs of involvement of the spinal cord in the form of neurologic disturbances.

COMMENT

From a review of the relationship of the different types of anemia to changes in the spinal cord it seems that only progressive pernicious anemia produces the microscopic picture of "degenerative genuine myelitis" (Henneberg's classification). It must be emphasized that anemia in itself, that is, the lack of hemoglobin and oxygen, does not act destructively on the nerve fibers of the spinal cord, but that toxins of unknown origin act simultaneously on the hematopoietic system and spinal cord. These toxins are not identical with the chemically well defined substances of group *2a* of Morawitz and Denecke, which in animal experimentation could not produce "degenerative genuine myelitis." Neither are they identical with the hypothetic cancer toxin or toxins formed in other neoplastic diseases producing severe cachexia. In the rare instances of cancer of the stomach producing subacute combined degeneration of the spinal cord, Naegeli's theory seems the most convincing, i.e., in these cases one is dealing with a combination of cancer and progressive pernicious anemia (Addison's anemia).

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36. Barker: Neutrophilic Myelocytes in the Cerebrospinal Fluid of a Patient Suffering from Myeloid Leukemia and Their Significance for the Diagnosis of Myeloleukemic Infiltrations of the Leptomeninges, South. M. J. **14**:137, 1921.

37. Rosenkranz, G.: Hirnblutungen bei Leukaemie, Frankfurt. Ztschr. f. Path. **35**:358, 1927.

38. Henneberg (footnote 1, first reference).

Degenerative genuine myelitis, as described in anemias combined with the puerperium, malaria and syphilis, is most probably due also to toxic involvement and not to the anemia in itself.

Addison's (Biermer's progressive pernicious) anemia and the anemias following infestation with *Bothriocephalus latus* are the only anemias producing the typical picture of subacute combined degeneration. Here again the anemia is independent of the changes in the spinal cord; one may precede the other or both may occur simultaneously. The modern conceptions about the etiology of Addison's disease and the fact that the disease in infestation with *Bothriocephalus latus* occurs only after the death of the helminth make it most likely that the toxin which acts destructively on the spinal cord and on the hematopoietic system is absorbed from the gastro-intestinal tract and circulates in the blood.

Changes in the spinal cord occurring in other anemias, like leukemias, are mostly myelomalacias, sequelae to vascular disturbances—hemorrhages, perivascular infiltrations, endarterial changes and the like. In neoplastic diseases secondary ascending degenerations of the posterior columns are met with frequently following metastases to the vertebrae or the meningeal coverings.

The microscopic changes which are produced by the toxin of Addison's anemia do not resemble those in disseminated sclerosis as can be seen by the different reactions of the fibrous glia. Therefore, the name of "combined sclerosis" should not be applied to the changes in the spinal cord in this disease. Subacute combined degeneration seems to be a more adequate term assigned to this toxic degenerative genuine myelopathy.

Furthermore, it is suggested to restrict the theory "that this disease is produced in anemias" more precisely to the term of "certain hemolytic anemias especially in a progressive pernicious type of anemia."

SUMMARY

1. Studies of changes in the spinal cord produced in different forms of anemia were made from our own material and cases reported in the literature.

2. The classification of Morawitz and Denecke was adopted for the various types of anemia, that of Henneberg for the different forms of myelopathy (myelitis).

3. Degenerative genuine myelopathy (myelitis) was found only in hemolytic anemias, mostly in the form of subacute combined degeneration (funicular myelitis).

4. The changes mentioned were not found in anemia resulting from increased waste of blood, in hypoplastic anemia and in chlorosis.

5. In leukemias the pathologic changes in the spinal cord are mainly those of myelomalacia, being produced by vascular changes such as hemorrhages and perivascular infiltrations.

6. In anemias combined with severe cachexia and with neoplastic disease, the changes in the spinal cord could often be traced to other diseases, such as arteriosclerosis or syphilis. In the absence of these two diseases, the changes consisted mostly of secondary ascending degeneration of the posterior columns. Either these were produced by lesions of the posterior roots due to metastases to the vertebrae and the meninges, or they were the sequelae of a local compression myelopathy (myelitis) producing secondary descending degeneration of cerebrospinal fibers.

7. The theory that cancer produces a specific toxin and acts destructively on the spinal cord could not be substantiated. In our material no degenerative genuine myelopathy (myelitis) in cancer of the stomach could be found. In the few cases of carcinoma of the stomach reported in the literature which showed changes in the blood characteristic of pernicious anemia and subacute combined degeneration of the spinal cord, Naegeli's theory appears most applicable—that such cases represented a combination of Addison's anemia with cancer of the stomach.

8. The statement advanced that subacute combined degeneration of the spinal cord occurs in all types of anemia is not accurate. It should be limited to hemolytic anemia, especially to progressive pernicious anemia and to rare cases of hemolytic anemia from other causes, for example, that caused by infestation with *Bothriocephalus latus*.

ABSTRACT OF DISCUSSION

DR. ARMANDO FERRARO: This paper constitutes a really fundamental piece of work. The amount of material is tremendous; the work has been considerable, and the authors are to be congratulated for the attempt to establish a specific pathology for pernicious anemia. The comparative material that they have presented is, I think, the most complete I have ever looked over, especially in connection with lesions of the spinal cord in other types of anemia. The work appears to me complete, and I believe that the present contribution has filled a gap that was present in this field of neuropathology.

I wish to mention particularly the predilection that the lesions in pernicious anemia seem to have for the dorsal segment of the spinal cord. It is well known that in the pathologic condition of the spinal cord one often observes lesions that involve predominantly the dorsal segment of the spinal cord; this is true for degenerative as well as for traumatic conditions. Furthermore, one finds that the lesion in the less severe cases of anemia is precisely located primarily in that region. Why do these lesions have such a predilection for the dorsal region of the spinal cord? I cannot say. It may be because of the vascular condition of that region. It is well known that the lumbar and cervical regions seem to possess a more pronounced network of vascular anastomosis than the dorsal region. Lack of appropriate nutrition may account for the major vulnerability. Another regional predilection of the lesions, especially in various types of anemia, is the

predilection for the posterior column. This is another difficult question. Is one dealing here also with a diversity of blood supply to the various columns, or is there something else in the line of chemical structure of the various areas of the spinal cord? I believe that the answer may come through appropriate histochemical investigations that establish differences in the composition of the various columns. Such an effort has been already partially made by two Italian physiologists who have made chemical analyses of the various areas of the spinal cord and have found differences between the lateral and posterior columns.

I agree with Dr. Weil and Dr. Davison that in other conditions of anemia one does not find the so-called typical subacute combined degeneration of the spinal cord. They have shown that the lesions in the secondary type of anemia generally involve the posterior column alone or the pyramidal tract, or both the pyramidal tract and the anterior column. One must then admit, in the presence of the large amount of material which they have illustrated, that in the secondary type of anemia the microscopic picture differs from the one in pernicious anemia, in which there is a combined degeneration of the posterior and lateral columns.

In pernicious anemia, both the axis cylinder and the myelin sheaths are severely affected; this fact contrasts with other conditions, such as multiple sclerosis, for instance, in which the myelin sheath is affected primarily and the axis cylinders display a higher resistance.

Although, however, I agree in a general way that subacute combined degeneration is characteristic of the pernicious type of anemia, I should not entirely discard the possibility that some other type of anemia, such as anemias following diffuse malignancy, especially carcinoma, may produce in particularly severe cases the same pathologic picture as that of pernicious anemia, that is, the subacute combined type of degeneration. It is true, as Naegeli says, that there may be a combination of malignancy and a pernicious type of anemia, but I believe that the possibility exists, whenever the malignancy is diffuse and with a large amount of metastasis, to find the microscopic picture recalling the one typical of pernicious anemia.

In regard to the practical absence of fibrous glia reaction in pernicious anemia, I agree with the authors, as I believe that the toxins may act on the axis cylinder and myelin sheaths as well as on the neuroglia cells, thus affecting the reactive capacity of the neuroglia elements in producing paraplastic substances. Altogether, I am in favor of Dr. Davison and Dr. Weil's conclusion as to the existence of a microscopic picture that is characteristic of pernicious anemia, and that other conditions of anemia seldom show the particular type of subacute combined degeneration which, in my belief, is a better name than subacute combined sclerosis.

Dr. Bernard Sachs: I think that the work has been well done and was well worth doing. The material was fortunately large, but it is curious how these questions recur from time to time. Almost similar presentations of this sort were made, I believe, some thirty years ago; they were not done as fully as this, but led to some of the puzzling questions presented here. As to why combined degeneration should be so frequently associated with pernicious anemia, I may remind you that this same question was studied more than thirty-five years ago by Williamson, who made careful studies of the blood vessels of the spinal cord and showed conclusively that the malnutrition of the cord was due to the insufficient blood supply of the posterior and lateral portions of the cord. At that time the studies were undertaken not for the purpose of proving the connection with pernicious anemia, but in connection with other diseases, especially the syphilitic diseases, in which the lateral and posterior columns are much more frequently affected than

the central or anterior portions; when there is any disease in the cord, the diseases of the blood vessels will be shown much more frequently in the posterior and lateral portions of the cord.

I was much interested in the charts. I had a feeling, basing it largely on clinical experience, that the secondary anemias following malignant growths, or in association with malignant growths of other parts of the body, are not nearly so important as is the frequent metastatic invasion, especially from tumors of the breast.

Dr. Israel Strauss: I, too, will compliment the writers of this paper on the assiduity with which they studied such an enormous amount of material and cut so many sections. In analyzing the results, I suppose that one might, to speak frankly, wonder what it is all about. I have learned that pernicious anemia caused what is called subacute combined sclerosis, or as Globus and myself suggested, funicular myelopathy, not a myelitis, because it is a degenerative process. It has been said that occasionally carcinoma presents this picture. I am of the opinion of Dr. Ferraro. How does one know that a toxic carcinoma occasionally, even when associated with a blood picture of anemia, may not cause a blood picture of this type? Naegeli can assume that it is coincidental, but nobody can prove that. As to all the other changes shown in all these cases, I do not think that anyone will make a diagnosis of combined degeneration in leukemia, in Hodgkin's disease or in any of the other conditions. It is true that the neurologist may find symptoms that indicate pathologic changes in the posterior or lateral columns, and in the absence of evidence of Hodgkin's disease or of a tumor may suspect a combined sclerosis. If the autopsy showed that the patient did not have this, that there was a tumor, Hodgkin's disease, or a leukemic infiltration, that cannot be helped; if the neurologist makes a diagnosis of subacute degeneration and there is not the blood picture of pernicious anemia (one must have a competent hematologist to say this), and the patient does not have an achylia gastrica, he must say: This is the picture of subacute combined sclerosis due to something other than pernicious anemia; or he must wait until the patient develops a blood picture of pernicious anemia and an achylia gastrica. I had a patient recently in the hospital, and my associates and myself were puzzled because she showed clinical signs of subacute combined sclerosis. In this case we could not find a blood picture of pernicious anemia, and there was no achylia gastrica; we made roentgen studies of the entire gastro-intestinal tract and could not find any malignancy. The spinal fluid and blood both showed a negative Wassermann reaction, and we were puzzled. Finally, attention was called to the fact that this woman had a perforation of the septum of the nose. We immediately took that case out of the class of subacute combined sclerosis. We treated the patient with bismuth and arsphenamine and she left us considerably improved. She presented a clinical picture of subacute combined sclerosis, but search revealed the cause. I think that what the authors have shown is, what we have all known, that in pernicious anemia there is a definite pathologic picture and that occasionally in cases of cancer one gets a picture of pernicious anemia plus this.

Dr. Ferraro thought that the poor blood supply in the dorsal region, where this disease starts, in comparison with the rich blood supply in the lower cervical region, is the reason for the appearance of the disease there; if, however, one explains this as caused by the toxin of pernicious anemia or of carcinoma, one would think that in the parts that have the less blood supply there would be less toxin, and therefore one ought to have more involvement in the lumbar and cervical region where there is more vascularity.

DR. FERRARO: The nutrition of the tissues makes the tissues more or less resistant to the toxin.

DR. STRAUSS: The authors have done a tremendous amount of work, and if it was not heretofore established in the literature that pernicious anemia has a typical microscopic picture in the cord, they have put the final stamp on it.

DR. WALTER M. KRAUS: One thing in this paper is parallel to what is known about the treatment for pernicious anemia. It is well known that liver extract is effective only in relieving the anemia and neurologic manifestations of pernicious anemia; it is ineffective in secondary anemia. Dr. Davison and Dr. Weil have shown that the characteristic changes of pernicious anemia are peculiar to that condition and do not appear in secondary anemia. The parallel observations on the neuropathology and treatment in this group of cases strengthens the conclusions which have been drawn in regard to both their neuropathology and their treatment.

The object of the paper is merely to establish facts based on other facts: in this instance, what may be seen by comparing what is found under the microscope by what has been found in the patient during life. Such demonstrations of facts have immeasurably more weight than clinical observations, and increase the accuracy of clinical diagnoses. It may lead to the possibility of diagnosing subacute combined degeneration of the spinal cord more accurately, for in the event of finding a clinical picture such as this, without finding any other evidence of pernicious anemia, one would be compelled to reexamine the patient to see whether the clinical picture is really subacute combined degeneration of the spinal cord. When such increased diagnostic skill is attained, one will be able to match clinical diagnosis with pathologic observations.

DR. JOSHUA A. LEINER: I think that the German investigators, particularly Siemerling and Rock, who have worked on funicular myelitis, have shown the difference between that condition and multiple sclerosis. They particularly have shown that the disease begins near the blood vessels. It is a blood-borne toxin, and the type of neurotoxin that produces a fragmentation of the axial fibers primarily. Japanese investigators in experimental lead poisoning have shown a similar pathologic process in peripheral neuritis. Here also appears primary axial fragmentation. In multiple sclerosis one finds involvement of the myelin substance first; it becomes markedly edematous and then impinges on the axial fiber, which is secondarily involved. The neurotoxin of multiple sclerosis is probably borne through the lymphatics, whereas in funicular myelitis it is blood-borne. I believe that this is the fundamental difference and accounts for the slowness of reactive glial phenomena. Multiple sclerosis is a slow process, giving time for glia formation and other conditions, whereas in funicular myelitis this condition does not prevail.

DR. LOUIS CASAMAJOR: I shall add my appreciation of the presentation. I believe that this is a matter of considerable moment, even if the conclusions that may come from the data presented may be similar to conclusions drawn before. For a long time we have all thought, as Dr. Davison pointed out, that the achlorhydria, the anemia and the combined sclerosis were all parts of a general disease picture and symptoms, the cause and nature of which are still being sought. We have all seen this particular triad develop in various ways: sometimes the pernicious anemia first, and not infrequently the combined degeneration first; sometimes either symptom may never appear. I have seen what Dr. Davison has pointed out about the involvement of the peripheral nerves in these conditions. I was particularly interested in that idea, because I have seen some cases of per-

nicious anemia with neurologic symptoms that were not combined degeneration, but appeared to be a subacute or chronic neuritis; these were all in patients who had been placed on a liver diet. I thought that possibly the influence of the liver diet might have determined changes in the peripheral nerves rather than in the spinal cord. I am not in favor of adhering to a name because it has always been used if that name is not descriptive. I take it that Dr. Davison means only to call subacute combined sclerosis, subacute combined degeneration. I should stand with him in a desire to change that name and call the thing what it really is.

DR. DAVISON: In answer to Dr. Strauss I must emphasize that terminology is an important thing. A process should be called by its proper name, and, as he will agree with me, the term "combined sclerosis" is a poor name. I have not tried to impress you with the fact that I am showing something new in changes in the spinal cord in pernicious anemia. In our paper we emphasized that the microscopic picture has been often and thoroughly described and is well known. What we attempted to bring out in the microscopic changes of the spinal cord in various forms of anemia, is the differences in the glial reaction types. These types of changes were not investigated thoroughly before. Lastly, I believe that with this work we are calling to the clinician's attention that in no cases should the condition be diagnosed clinically as subacute combined degeneration unless one suspects pernicious anemia. Neurologic signs and symptoms suggestive of subacute combined degeneration will not show the typical histologic picture of subacute combined degeneration unless the case is one of progressive pernicious anemia.

TRAUMATIC CEREBRAL HEMORRHAGE*

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We shall present a series of fatal cases of cranial traumatism studied at autopsy, particular attention being paid to those showing multiple miliary hemorrhages not immediately related to the traumatic focus and constituting the type known as multiple concussion hemorrhages. We shall also give a clinical review of a series of cases of concussion presenting late evidence of severe damage to the brain.

The effects produced by concussion of the brain have been described by many writers. In 1860, Bauchet,[1] studying the mechanism of traumatic lesions of the brain and the oscillations of the cranium, thought that these oscillations must be transferred to the brain mass, and that the insult may be carried to the point of more or less considerable derangement of the molecules of the brain. When confined to certain limits and under certain conditions, the brain substance will resist the external violence and will not be the seat of any visible or appreciable alteration. The mechanism did not escape Morgagni, who described it as follows: "Cerebrum, agitatum versus caput durum et retropulsum per illud, subit uno momento duos motus contrarios; si cranium non frangitur, totus impetus percussionis dirigitur in cerebrum" (The brain, driven against the skull and repelled by it, is thus subjected, within a moment, to two motions in opposite directions; if the skull is not fractured, the whole force of the percussion is directed against the brain itself). Bauchet distinguished between concussion (commotio) and contusion, and asked when the first ends and the second begins; he concluded that in concussion a more or less extended surface of the brain is affected and that the changes consist only of a vascular injection or of small miliary extravasations without notable alteration of the brain substance, but that when the brain substance (le pulpe nerveuse) is so altered that the damage is limited and more profound, when it exhibits an intimate mixture of extravasated blood and brain substance, and when the small miliary lesions are no longer neatly circumscribed and isolated, the lesions are those of contusion.

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1. Bauchet, L. J.: Des lésions traumatiques de l'encéphale, 1860.

Gowers [2] stated that in concussion the occurrence of hemorrhage is due largely to the slight support offered by the cerebral tissues to the vessels. This is less in the old than in the young on account of the larger size of the perivascular spaces occupied by mobile liquid. The loss of consciousness is probably due to the suddenness of the lesion or lesions causing an arrest of function of the cortex by irritation. Sudden death is probably caused by the shock and the inhibition of the vital functions in the medulla. In discussing encephalitis, Gowers said:

> Injury commonly sets up inflammation in the meninges as well as the brain, but now and then the former escape and the latter is affected beneath the surface, apparently because the white substance is more easily injured than the gray. All forms of injury may bring this result, blows or falls on the head, fractures of the skull, and punctured wounds. It may occur from mere concussion, but is undoubtedly set up by the mechanism of interstitial laceration. Usually cerebritis is immediately below the seat of the injury, much less commonly it occurs on the opposite side of the brain from contrecoup.

The contrecoup usually damages the center of the convolution, so that a shallow depression in its surface ultimately develops.

Gowers cited two instances to show that traumatic influences were seemingly sometimes effective in producing paralysis agitans by the concussion of the nerve centers. One of the most severe cases he had seen commenced in a patient at the age of 40, and the only traceable cause was a fall from a horse four months before the onset. There was no injury to a limb.

Pierce Bailey,[3] however, stated: "It is impossible to explain the genesis of traumatic paralysis agitans further than to note the sequence of events and to infer that the injury stands in some causal relation to the disease." Walz [4] expressed the belief that the disease can appear only in persons with previous deterioration of the nervous system. While the truth of such a theory cannot be denied, it cannot be proved because it is rarely possible to demonstrate any predisposition in the patient. There is no means of knowing that the disease would not have developed eventually under any circumstances irrespective of slight injuries.

In 1924, Cassasa [5] reported five autopsies showing traumatic cerebral hemorrhages. In all these cases, there was a history of injury to the head. Momentary unconsciousness occurred at the time of injury.

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2. Gowers, W. R.: Diseases of the Nervous System, 1888.

3. Bailey, Pierce: Diseases of the Nervous System Resulting from Accident and Injury, 1909.

4. Walz: Die traumatische Paralysis Agitans, Vierteljahrs Figerecht-Med., 1896, vol. 12, p. 1323.

5. Cassasa, C. B.: Multiple Traumatic Cerebral Hemorrhages, Proc. New York Path. Soc. **24**:101 (Jan.-May) 1924.

After a lucid interval, varying from three to twenty-four hours, there developed a period of marked irritability with increase of deep reflexes, which was followed by unconsciousness. At autopsy, sections of the brain showed multiple, usually punctuate, hemorrhages scattered through various parts of the parenchyma. No laceration of the scalp, no fractures of the skull, no cortical lacerations or hemorrhages, except occasional slight hemorrhages in the pia, were found. Cassasa considered this type of traumatic hemorrhage to be relatively rare as he found only these five cases during a period of ten years' work with the coroner's physician and the chief medical examiner of New York County. While this type of lesion was apparently recognized by those performing medicolegal autopsies, its significance, from a clinical standpoint, had not been appreciated.

In 1927, Osnato and Giliberti [6] reported clinical studies of 100 cases of concussion of the brain with or without fracture of the skull and a pathologic study of one of Cassasa's cases. The study of the microscopic changes was made by Dr. Leon H. Cornwall. They concluded that:

> Anatomic and clinical investigations seem to show definitely that our conception of concussion of the brain must be modified. It is no longer possible to say that "concussion is an essentially transient state which does not comprise any evidence of structural cerebral injury." Not only is there actual cerebral injury in cases of concussion, but in a few instances complete resolution does not occur, and there is a strong likelihood that secondary degenerative changes develop. When this happens, we have a condition which, clinically at least, resembles some of the reactions seen in encephalitis. We feel, therefore, that the postconcussion neuroses should properly be called cases of traumatic encephalitis.

Cassasa's explanation of the mechanism of concussion depended on the existence of the so-called perivascular and perineuronal spaces and the identification of a network of fine fibrils connecting the external wall of the blood vessel with the surrounding brain tissues across the perivascular spaces. He stated:

> Sudden over-filling of the perivascular lymph space with cerebrospinal fluid conceivably could produce laceration of a vessel by tearing of its wall in the neighborhood of such a fibrillar attachment. Otherwise, without such an attachment, the laceration of a vessel surrounded by fluid could not be produced by any pressure exerted through that fluid which would only tend to compress the vessel but not lacerate it. Such an increase of cerebrospinal fluid in one perivascular space could be caused by the cerebrospinal fluid from the surface of the brain being driven into it by pressure exerted by the change of shape of the skull—the result of a blow or fall. This change of shape under an area of violence is in the direction of flattening and diminution of space for the cerebrospinal fluid in

6. Osnato, Michael; and Giliberti, Vincent: Postconcussion Neurosis—Traumatic Encephalitis, Arch. Neurol. & Psychiat. **18**:181 (Aug.) 1927.

that area. This fluid must find its way out of that area through the various sulci of the brain and in connection therewith, such fluid as cannot find its way through these channels, must find a way into the perivascular lymph spaces in the reverse direction of the normal flow in these channels.

The existence of perivascular spaces is still questioned. Some observers think that they are artefacts, and others claim that they exist only under pathologic conditions. The consensus, however, supports the original conception of His (1865) that there exists a system of richly inter-communicating spaces in the nerve tissues and around the blood vessels. The work of Weed in this connection is well known.

In this study we shall limit ourselves largely to experience with this type of traumatic cerebral hemorrhage, emphasizing particularly the frequency of its incidence and its great clinical and medicolegal importance. Our material consists of 309 autopsies showing cerebral injuries and a number of selected clinical cases of injuries to the head.

TABLE 1.—*Nature of Injuries*

Highway Accidents:	
Pedestrians struck or run over by pleasure cars, trucks, jitneys, taxis, trolley-cars, horse-drawn vehicles, trains, etc.	146
Collisions of autos with post, tree, curb, trolley, trains, motorcycles, etc.	43
Homicides:	
Homicides by assault	6
Falls:	
On street, stairs; from window, scaffold, buildings under construction, ladder, porch, balcony, etc.	97
Miscellaneous Casualties:	
Elevator accidents, explosions, struck by machinery, crushed, etc.	17
Total	309

PATHOLOGIC MATERIAL

During a period of two years ending May 16, 1927, one of us (H. S. M.), as chief medical examiner of Essex County, N. J., performed 309 autopsies on persons dying of cerebral injuries, exclusive of gunshot and other penetrating wounds of the head. The County of Essex, with Newark as its center, is a large metropolitan manufacturing area with a population of about 775,000. Table 1 summarizes the causes of injury in the 309 cases.

The ages varied from infancy to old age. Males predominated. The cases represented practically 99 per cent of the deaths from cerebral injuries occurring in the community within a period of two years. The number was sufficient to give a fairly accurate estimate of the percentage incidence of the various types of traumatic cerebral hemorrhage likely to occur in industrial centers.

These types as found and classified at autopsy are set forth in table 2.

The incidence of laceration of the scalp, hematoma, fracture of the skull and other complications is set forth in table 3.

By traumatic encephalitis is here meant an acute, diffuse, active hyperemia of the brain characterized grossly by a purplish or scarlet discoloration of the gray matter similar to that seen in rabies and tetanus.

Extradural Hemorrhage.—This type of hemorrhage was always associated with fracture of the skull, usually of the vault, extending downward into the middle fossa along its least convex surface, and

TABLE 2.—*Types of Traumatic Hemorrhage Found in 309 Autopsies*

		Number of Cases	Percentage
1. Extradural hemorrhage		25	8.2
With fracture of skull	25	...	....
Middle meningeal hemorrhage	24	...	....
Anterior meningeal hemorrhage	1	...	....
2. Cortical laceration and hemorrhage		254	82.0
Direct	47	...	....
(Brain injured directly beneath point of violence)			
With fracture of skull	45	...	....
Without fracture	2	...	....
Contrecoup	177	...	....
(Brain injured diagonally opposite point of violence)			
With fracture of skull	167	...	....
Without fracture	10	...	....
Combination	30	...	....
(Direct and contrecoup)			
With fracture of skull	29	...	....
Without fracture	1	...	....
3. Deep multiple hemorrhages associated with cortical injuries		14	4.6
With extradural hemorrhage	1	...	....
With direct cortical laceration and hemorrhage	3	...	....
With contrecoup cortical laceration and hemorrhage	10	...	....
4. Deep multiple hemorrhages without fracture of skull or gross surface lesions		9	2.9
5. Unclassified subdural and pia-arachnoid hemorrhages		7	2.3
Total		309	100.0

TABLE 3.—*Incidence*

	Number of Cases	Percentage
Laceration of scalp	116	34.0
Hematoma or hemorrhage in scalp	287	92.0
Fracture of skull	278	90.0
Suppurative meningitis	12	3.9
Abscess of brain	3	0.9
Traumatic encephalitis	2	0.6

tearing either the anterior or the posterior branch of the middle meningeal artery or the main artery itself near the foramen spinosum. The anterior meningeal artery was ruptured in only one instance. The resultant clinical picture is usually clearcut, and the treatment in uncomplicated cases is too well known to need description.

Cortical Laceration and Hemorrhage.—Laceration of the vessels of the leptomeninges with hemorrhage in the pia-arachnoid and cortex of the brain constituted by far the most frequent and important traumatic lesion within the cranial cavity. It occurred in 82 per cent of the cases.

The usual postmortem observation was pia-arachnoidal hemorrhage, either directly beneath the point of violence, at the site of contrecoup, or

in both places, associated generally with small multiple hemorrhages, occasionally punctate but commonly streaky, in the cortex, running at right angles to the surface of the brain. In the majority of the cases, the underlying white matter was fairly free and clear. When the injury was extensive, the hemorrhages were confluent and produced large areas with more or less extensive softening which often involved the underlying white matter. Contrecoup laceration and hemorrhage in the cortex was the most frequent type of traumatic hemorrhage. It occurred in 57 per cent of the cases. We have, however, never found fracture of the skull at the site of contrecoup, unless we except the small, almost insignificant fracture lines often seen in the supra-orbital plates of the frontal bone. It is generally accepted that this type of hemorrhage results from tearing of the vessels of the pia-arachnoid.

Deep Multiple Hemorrhages Associated with Cortical Injuries.—In a certain percentage of cases of hemorrhage with cortical laceration, with or without fracture of the skull, the parenchyma of the brain is damaged apart from the local injury. Multiple streaky hemorrhages usually occur in the brain stem, the pons, medulla and basal nuclei. Multiple hemorrhages of a similar kind are frequently seen in ordinary apoplexies. Such cases have been reported by Wilson and Winkelman.[7] Their mode of production has not been definitely explained, but Mills[8] stated the belief that they "are due as Duré pointed out, in his cases of traumatism in dog experiments, to the sudden universal displacement of cerebrospinal fluid in such a way that immediate conditions of vacuolation are created at many points around the small vessels. The external support and pressure being removed, hemorrhages take place in consequence into the vacant spaces. A sudden hemorrhage into the interior of the brain strikes the brain a blow from within, which is comparable to the blow on the cranium without. The blows from within and from without produce similar disturbances in the brain."

Unclassified Subdural and Pia-Arachnoidal Hemorrhage.—This group comprises a small number of scattered or discrete, blotchy pia-arachnoidal and subdural hemorrhages unassociated with any degree of cortical injury. Tearing of small branches of the venous sinuses probably explains most of these hemorrhages.

Deep Multiple Hemorrhages without Fracture of Skull or Gross Surface Lesions.—In 309 autopsies at which cerebral injuries were found, the type of hemorrhage described by Cassasa was encountered in nine cases, or 2.9 per cent. This percentage was much higher than that found by Cassasa and others.

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7. Wilson, George, and Winkelman, N. W.: Pontile Bleeding, Tr. Am. Neurol. A., 1925, p. 157.

8. Mills, Charles K.: Tr. Am. Neurol. A., 1925, p. 171.

In eight of the cases there was no fracture of the skull. In one case a small fracture of the supra-orbital plate of the frontal bone was found, probably contrecoup in origin and quite insignificant. In none of the nine cases was there cortical laceration and hemorrhage or other surface injury to the brain or its coverings. Occasionally, there was a small amount of scattered pia-arachnoidal hemorrhage. In the central portions of the brain, not only in the white matter, but in the gray matter of the basal nuclei, multiple, small, discrete, punctate and sometimes confluent hemorrhages were observed as the only gross evidence of injury to the brain. The portions of the brain chiefly involved were the corpus callosum, the corpora striata and the corona radiata. The hemorrhages were rarely seen below the tentorium cerebelli. In one case, there were small hemorrhages in the upper part of the cervical cord.

Microscopic examination showed that most of these punctate hemorrhagic areas consisted of cross-sections of capillaries filled with red blood cells which had leaked into the surrounding perivascular spaces and distended them. In fact, many of the capillaries were actually occluded by agglomerated erythrocytes with the formation of a considerable network of fibrin. In many of these areas the distention of the perivascular space had been so great that there was a rupture of the structure with an extravasation of erythrocytes into the surrounding brain tissue. Aside from the formation of fibrin thrombi, there was no indication of any inflammatory reaction as most of the cases here reported were those of patients who died soon after the injury.

The perivascular space limits the hemorrhage, causing it to encircle the vessel in a ringlike manner. Its anatomic location is similar to that observed in epidemic encephalitis as the result of an inflammatory defense reaction. In fact, Schmidt [9] introduced the term "ring hemorrhage" to describe the appearance of the hemorrhages found in so-called purpura of the brain (hemorrhagic influenzal encephalitis). It is perhaps the most descriptive term that could be used.

Schmidt stated, "Capillary hemorrhages developing under completely different conditions behave microscopically in a similar way; that in the three groups of diseases, namely, spontaneous purpura of the brain (hemorrhagic encephalitis), septicopyemic and traumatic hemorrhage, the ecchymoses of the white matter in the large majority of cases have the character of ring hemorrhages."

We believe that in the majority of cases Cassasa's theory best explains the mechanism of production of these hemorrhages. We shall therefore speak of them as "concussion hemorrhages." They practically never occur when the vault of the skull is fractured. It would seem that

9. Schmidt, M. B.: Beitr. z. path. Anat. u. z. allg. Path. **7**:419, 1925.

fracture of the skull, by releasing and distributing the increased intracranial pressure at the time of the violence, prevents the forcing of the cerebrospinal fluid into the perivascular spaces.

Another theory that must receive serious consideration is that the hemorrhages are caused by fat emboli. In our examination of the slides in one of Cassasa's cases studied by Cornwall, we found unquestionable evidence of fat emboli in the vessels of the brain.

The problem of the production of serious or fatal lesions by fat emboli is, however, still unsettled. Many believe that sudden death following bone injuries and operations, when the panniculus adiposus is traumatized, is due to it, but the majority, while admitting the common occurrence of fat embolism after such injuries, consider it of little pathologic importance.

One of the most ardent supporters of the importance of fat embolism was Bissell.[10] In 1917, he reported three deaths attributed to surgical shock; one followed an operation for repair of a ventral hernia and two occurred after amputation of a breast for cancer; at autopsy he found innumerable droplets of fat in the blood from the right side of the heart and lungs, petechial hemorrhages in the visceral pleura and skin, and bloody, frothy edema of the lungs. Microscopic sections showed countless fat emboli in the capillaries of the lungs and many in the brain, kidneys, liver, heart, muscles, spleen, suprarenals and skin. In one of his photomicrographs was depicted a lesion in the brain, similar in its location and character to what we have designated as a "concussion hemorrhage." The gross description of the brain, however, recorded only marked edema of the leptomeninges.

In demonstrating fat droplets in the viscera at autopsy, Bissell called attention to the necessity of a special technic at autopsy, which consisted in removing the organs of the chest and abdomen *en masse*, with careful washing of the knife and viscera to avoid contamination.

He believed that death was due to an increased viscosity of the blood from the admixture of fat, which resulted in a rise of venous blood pressure and a fall of arterial pressure similar to that which occurs in shock. He also believed that many cases of postoperative shock, following operations on bones, fracture work and operations in obese persons, were the result of fat embolism. He stated that the seriousness of fat embolism from a surgical standpoint was recognized by Roswell Park as early as 1884.

Askanazy[11] was of the opinion that before the diagnosis of shock is made, the presence of arterial lesions or evidence of embolism, especially

10. Bissell, W. W.: Pulmonary Fat Embolism: A Frequent Cause of Post-Operative Surgical Shock, Surg. Gynec. Obst. **25**:8, 1917.

11. Askanazy, M., in Aschoff: Pathologische Anatomie, Jena, Gustav Fischer, 1923, vol. 1, p. 100.

fat embolism in cases of injury to bones, must be definitely excluded. In fractures of, or operations on, bones, there is a marked disturbance of fat tissue in the bone-marrow. Hemorrhage into the bone-marrow, because of the tension produced by the resistance of the bone cortex, pushes the fat into the wide sinuses and fat droplets are forced into the venous circulation. In every case of fracture, careful postmortem examination of the lungs will reveal a surprisingly large number of fat emboli. Usually, there are no symptoms. In severe cases, dyspnea and bloody edema of the lungs may be followed by death from asphyxiation. The fat droplets which are not arrested in the lungs pass into the systemic circulation and produce emboli in the heart, kidneys, brain and other organs. As a rule, however, most of the fat is deposited in the pulmonary capillaries, which act as the first filter for the venous circulation. If the foramen ovale is patent, fat is more likely to be present in the systemic circulation. In such cases there may be clinical symptoms of cerebral injury and pathologic evidence of numerous punctate hemorrhages throughout the white matter of the brain.

Muir [12] stated that:

> Probably in every case of fracture of bone, fat enters the circulation, but it only occasionally gives rise to symptoms and a fatal result is rare. In fatal cases, the fat is found to be present in large quantities in the form of globules in the small arteries and capillaries of the lung, whilst there is usually marked edema around and also scattered hemorrhages. Death appears to result chiefly from mechanical plugging of the pulmonary capillaries, and the chief symptoms are of a pulmonary nature. A certain amount of fat may pass through the pulmonary circulation and emboli may occur in other organs. In the brain small hemorrhages have been found in some instances.

Boyd [13] stated:

> Fat emboli enter the blood-stream as the result of fracture of the bones with laceration of the marrow, or they may follow convulsive seizures, or even a severe blow. The fat globules can be seen distending the pulmonary capillaries and appearing as highly refractile bodies which stain red with sudan III. Animal experimentation has shown that the condition is not nearly so serious as was formerly supposed. Indeed, it is probably of little significance.

McCallum [14] stated:

> Emboli may be constituted of droplets of fat which are set free into the blood-stream from the adipose tissue. Such globules lodge, as a rule, in the capillaries of the lungs, and are pressed into a sausage-shape by the blood of the pulmonary artery. They produce no obvious change in the appearance of the lung and must be searched for by special stains. They are commonly introduced by some

12. Muir, Robert: Text-Book of Pathology, Philadelphia, J. B. Lippincott Company, 1924, p. 75.

13. Boyd, William: Surgical Pathology, Philadelphia, W. B. Saunders Company, 1925, p. 150.

14. McCallum, W. G., in Muir: Text-Book of Pathology, Philadelphia, W. B. Saunders Company, 1924, p. 22.

mechanical injury to the bones, such as a fracture, but even a severe blow seems sufficient to cause such a commotion in the marrow as to introduce some of the abundant fat into the venous channels. Fat embolism also occurs in a number of convulsive diseases, and particularly in such conditions as delirium tremens, in which violent exertion of the individual plays a part.

Although it is conceded that even a slight traumatism of the panniculus adiposus, unassociated with extensive bone or other injuries, may cause fat embolism, it is usually not followed by serious results. Analysis of our nine cases showed that in six there had been no extensive injuries to the body, the injuries being entirely confined to the head. In these cases, therefore, fat embolism probably played no part in the production of the hemorrhages. In the other three, there were extensive injuries to the body, with fractures of the long bones. In the latter cases, fat embolism might have been expected, but in only one of them were fat droplets found in the blood of the right side of the heart at autopsy and a large number of autopsies, at which extensive injuries to the body with fracture of long bones but without injury to the head were found, failed to show the type of hemorrhages described by Cassasa. This fact is an important argument against the theory of the causation of these cerebral hemorrhages by fat embolism. Of the cases in which we had every reason to expect fat emboli in the brain, only a few showed droplets of fat in the venous and capillary blood of the lungs.

We therefore believe that our observations support Cassasa's theory that these hemorrhages are due to concussion. Since it is difficult to prove that fat embolism is not the causative factor, another series of similar cases should be investigated by special methods for the detection of fat emboli in the blood of the right side of the heart and lungs, with careful histologic search for their presence in the viscera.

Some observers are of the opinion that multiple hemorrhages of this type are agonal, but we have never seen them at autopsy in cases of sudden and violent death unassociated with injury to the head.

Whatever their mode of production, whether from concussion, fat emboli, or other cause, ringlike hemorrhages, as demonstrated in our series, do occur, and in some instances are the only gross lesions found to account for death. In cases of mild concussion followed by recovery, it is possible that a small number of minute hemorrhages may exist in the less vital parts of the brain without giving rise to symptoms. In more severe cases the inflammatory reaction following the insult to the brain forms an important theoretical basis for the explanation of the symptomatology of postconcussion neuroses and psychoses.

Clinical diagnosis of this type of hemorrhage is difficult soon after injury. Symptoms of compression do not arise, as the total amount of hemorrhage even over a large area is insufficient to produce them and the spinal tap will not contain blood.

REPORT OF CASES IN WHICH AUTOPSY WAS PERFORMED

CASE 1.—*History.*—A chauffeur, aged 22, was injured when a bus that he was driving collided with a tree. He sustained a compound fracture of the left femur, a simple fracture of the right femur and numerous brush abrasions of the lower extremities. He died two days later. The clinical diagnosis was cerebral embolism.

Autopsy.—There was slight hemorrhage in the scalp over the right occipital region. No fracture of the skull or laceration of the scalp was present. The pia-arachnoid showed no evidence of hemorrhage, and there was no laceration of the cortex. On section, a rather remarkable condition was seen. Situated chiefly in the white matter of the cerebral hemispheres and most marked in the coronae radiatae of the frontal lobes were innumerable small punctate hemorrhages ranging in size from almost invisible red spots to hemorrhages 1 mm. in diameter. These could not be wiped off. The lower lobes of both lungs were dark red,

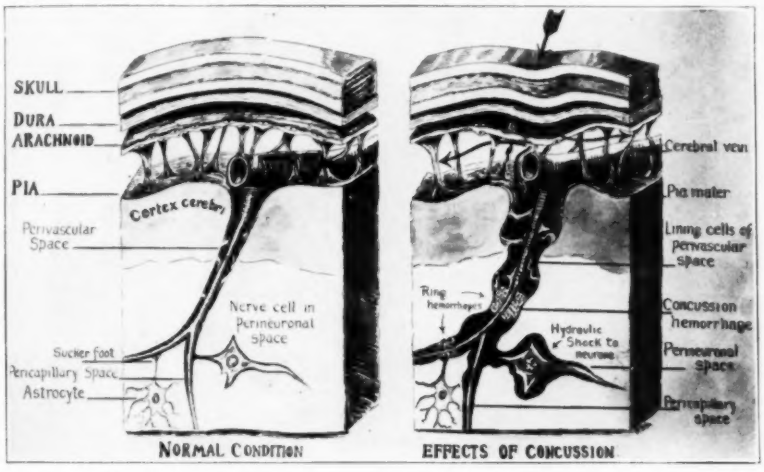

Fig. 1.—Schematic diagram of normal perivascular and perineuronal spaces on the left, and the probable mechanism of production of concussion and multiple concussion hemorrhages on the right.

and on section there was considerable fluid blood in the dependent portions containing fat droplets. The fluid blood in the right ventricle also contained fat droplets.

This was the only case in our series which showed evidence of fat emboli at autopsy. There was extensive injury to the bone. In addition, a definite hemorrhage in the scalp over the occipital region showed that external violence was applied to the skull.

CASE 2.—*History.*—An iceman, aged 36, while intoxicated, fell from a platform 25 feet high. He was unconscious when found. On admission to the hospital he had lacerations of the right frontal region and of the upper lip on the right side, and ecchymoses around both eyes. He had pin-point pupils, deviation of the eyes to the left, a right lower facial paralysis, rigidity of the lower jaw, absent abdominal reflexes, a rigid abdomen and active knee jerks. No clonus or Babinski sign was present. The next day he showed: flaccid paralysis

of the right side, pupils sluggish to light, and slow oscillatory movements of the eyeballs. The spinal fluid was under normal pressure and contained no blood. He lived three days. Death was preceded by delirium, stupor, incontinence of urine, a fall of systolic blood pressure to 88 mm. of mercury and a temperature that gradually rose to 106 F. The pulse rate was 160 and respirations, 60 per minute. Roentgen examination showed no fracture of the skull.

Autopsy.—There was a large laceration of the scalp over the right frontal region with an underlying hematoma. There was no fracture of the skull. No pia-arachnoidal hemorrhage or laceration was found. On section, the brain

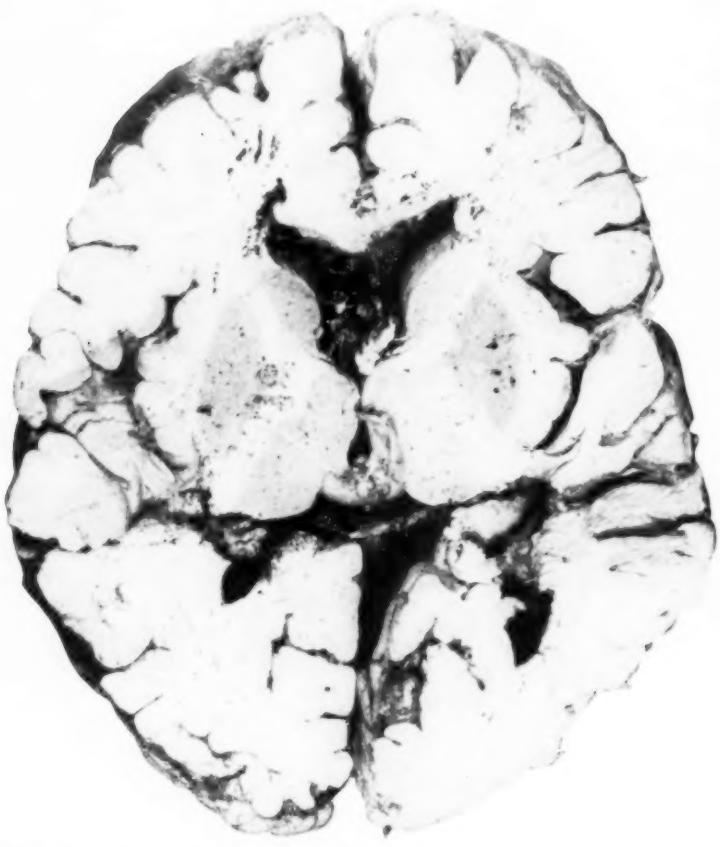

Fig. 2 (case 4).—Appearance of brain. Multiple punctate concussion hemorrhages may be seen situated chiefly in the corona radiata of both frontal lobes and in the corpora striata. The absence of any other injury to the brain should be noted.

showed numerous punctate hemorrhages in the left corpus striatum which did not wipe off. In the superior portion of the right temporosphenoidal lobe these hemorrhages were numerous, some of them measuring from 2 to 3 mm. in diameter, while others were hardly discernible to the naked eye. Over the back of the body considerable subcutaneous hemorrhage extended from the lower border of

the ribs down to the sacrum. A fracture dislocation was present through the right sacro-iliac joint. There was no evidence of fat embolism.

CASE 3.—*History.*—A man, aged 38, was pushed off the front porch of his home during an argument. He was taken to the hospital in a taxicab and was found dead on arrival.

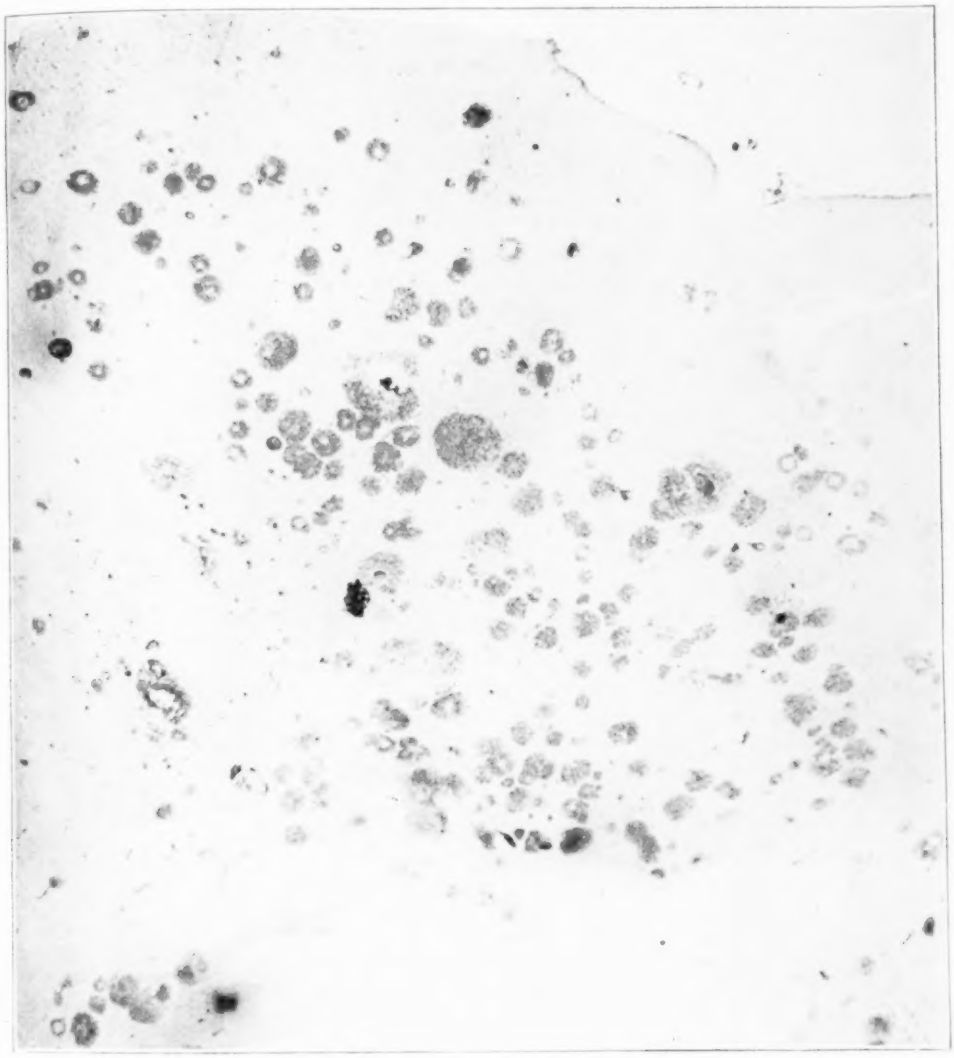

Fig. 3 (case 4).—Section through the corpus striatum. Innumerable "ring hemorrhages" with their perivascular distribution may be noted.

Autopsy.—Except for a hematoma over the left parietal region, there were no marks of injury on the body. There were no laceration of the scalp, no fracture of the skull and no cortical laceration or hemorrhage. In the inferior part of the left temporosphenoidal lobe, in the inner half of the left optic thalamus

and throughout the left globus pallidus were seen many small reddish areas ranging in size from almost invisible points to those from 1 to 2 mm. in diameter. These spots could not be wiped off. A few small hemorrhages were seen in the pons and medulla; situated in the right half of the floor of the fourth ventricle was a reddish area, 4 mm. in diameter, composed of small, multiple, punctate hemorrhages. In the upper part of the cervical cord, about 2 inches (5 cm.) below the foramen magnum, were a few small, punctate hemorrhages in the right posterior horn near Clark's column and in the posterior border of the left anterior horn. There was no injury to the spine or back.

These small hemorrhages were the only demonstrable lesions to explain death in an important manslaughter case. Toxicologic examination revealed less than 1 Gm. of ethyl alcohol per kilogram of brain tissue, indicating that the man was not intoxicated though he had been drinking. There were no indications of fat emboli and no injury on the body except the hematoma in the scalp. This was the only case in the series showing hemorrhages below the tentorium cerebelli and here the greater number was in the brain above.

Case 4.—*History.*—A man, aged 76, while going upstairs, stumbled and fell on his head. There was loss of consciousness but no vomiting. On admission to the hospital he was comatose, with unequal pupils. There was a small hematoma over the left upper and lower eyelids, a slight hemorrhage in the ocular conjunctiva, a laceration over the left eyebrow and brush abrasions on the left side of the face. He died two hours after admission, without regaining consciousness.

Autopsy.—There was a small amount of hemorrhage in the left temporal muscle and overlying scalp, and a laceration over the outer part of the left eyebrow. There was no fracture of the skull. There was marked edema of the brain with dilatation of the lateral ventricles, but no laceration or hemorrhage of the cortex. There were multiple, punctate hemorrhages in the coronae radiatae of the frontal lobes and innumerable small hemorrhages, smaller than a pinhead, in the white matter of the cerebral hemispheres over the roof of both lateral ventricles. There were a few similar areas in both corpora striata and over the ependyma of the third ventricle and the posterior horns of the lateral ventricles.

Case 5.—*History.*—A man, aged 55, while walking, was struck by a car. On admission to the hospital he was unconscious and cold; his breathing was slow, and there was an alcoholic odor to his breath. He slowly recovered to the point where he could be aroused with difficulty. Weakness of the left arm and the right leg developed. He died seven days after admission.

Autopsy.—There was a healing laceration over the left side of the forehead with a small area of greenish discoloration in the scalp around the wound. There was no fracture of the skull. There was considerable cerebral edema with dilatation of the lateral ventricles, and slight pia-arachnoidal hemorrhage over the tip of the right occipital lobe, which was of contrecoup origin. There was no cortical laceration. In the genu of the corpus callosum, covering an area about 1 inch (2.5 cm.) in diameter, were four small areas showing multiple punctate hemorrhages, the largest being from 3 to 4 mm. in diameter. These hemorrhages could not be wiped off. There were a few similar scattered hemorrhages in the corona radiata beneath the second left frontal convolution and in the right lenticular nucleus. Except for multiple decubital sores over the back of the sacrum, no other lesions were found.

Case 6.—*History.*—A man, aged 54, under the influence of liquor, fell down a flight of stairs. On admission to the hospital, he was unconscious. There was

an alcoholic odor to his breath. He had a laceration of the right ear and a hematoma over the right frontal region. The pupils were equal, contracted and sluggish to light. The knee jerks were diminished. Roentgenograms of the skull revealed no fracture. Two days later, nystagmus, paralysis of the left arm, a left Babinski sign, left lower facial paresis and diminished abdominal reflexes on the right side were present. The systolic blood pressure rose from 140 to 170 and then dropped to 96. Four days after admission, a left temporal decompression was performed. The dura was found intact, and there was no evidence of increased intracranial pressure. He died shortly after the operation.

Autopsy.—The skull showed a surgical decompression over the right parietal region. There was no fracture of the skull, cortical laceration or hemorrhage. In the inferior part of the right cerebral hemisphere and to a slight extent in the left hemisphere were numerous small punctate hemorrhages which could not be wiped off. These were situated in the white matter. There were no fat emboli and no injuries to other parts of the body.

Comment.—This case demonstrates the difficulty of making a differential diagnosis on clinical grounds of the type of traumatic hemorrhage present. No benefit is to be derived from surgical procedures in the type here under discussion.

CASE 7.—*History.*—A man, aged 59, while walking, was struck by an automobile. On admission to the hospital he had multiple lacerations of the head and face, and a hematoma over the left occipital region. He complained of pain in the right side, but otherwise seemed to be in good condition. Sixteen days later, he began to talk incoherently, picked at the bed covers and manifested symptoms of mild delirium. He became more irrational and had to be restrained. Roentgen examination showed no fracture of the skull. A spinal tap yielded fluid that was clear and under slight pressure. The systolic blood pressure increased from 120 to 190 during the last three days of life. He died twenty-two days after the accident.

Autopsy.—There was a small healing laceration over the left occipital region with a surrounding hematoma displaying a variety of colors. There was no fracture of the skull. The pia-arachnoid was normal, except for edema. The gray matter of the cortex and of the basal nuclei was a distinct reddish, purplish gray, but there were no hemorrhages. In the left corona radiata were small areas showing small punctate hemorrhages which could not be wiped off. The anatomic diagnosis was traumatic encephalitis with multiple concussion hemorrhages.

CASE 8.—*History.*—A boy, aged 9 years, fell backward from a box, his head striking the ground. On admission to the hospital he was unconscious, and had a hematoma over the right frontotemporal region. The pupils were widely dilated. The pulse and respiration were normal. The blood pressure was 110 systolic and 60 diastolic. An hour and a half later, he had a convulsive seizure, with floating nystagmus to the left and jerking of the eyeballs to the right. There were retraction of the head backward and to the right and clonic movements of the eyelids and of the right side of the body. There was Cheyne-Stokes breathing. The blood pressure gradually rose to 170 systolic and 90 diastolic. It dropped a few hours before death. The day after admission, a right subtemporal decompression was performed. The dura was reddened and bulging. The exposed brain appeared to be congested. No clot was found. Roentgen examination showed no fracture. He died three days after admission.

Autopsy.—Hematoma was present over the right frontotemporal region. There were no laceration of the scalp, fracture of the skull or laceration or hemorrhage in the pia-arachnoid. The gray matter of the cortex and of the basal nuclei was

scarlet red. In the corpora striata were multiple punctate hemorrhages which could not be wiped off. The anatomic diagnosis was traumatic encephalitis and multiple concussion hemorrhages.

Comment.—Cases 7 and 8 are examples of what we have designated as traumatic encephalitis. In both cases the gray matter of the entire brain showed extreme congestion and had a distinct scarlet-gray hue. We have noted the same color in the brains of persons who have died from rabies, tetanus and sometimes sepsis. Such a lesion alone is enough to produce death, but in the cases cited multiple concussion hemorrhages were also present. Some think that death following acute alcoholism might explain these punctate hemorrhages, but they occurred in case 8, that of a boy, aged 9, in whom the alcoholic factor was eliminated.

CASE 9.—*History.*—A girl, aged 7 years, was struck by a car. On admission to the hospital she was unconscious. Death occurred the next day. The clinical diagnosis was possible fracture of the skull.

Autopsy.—Except for a few brush abrasions over the knee, legs and left hip, there were no marks of external injury. A large hematoma of the scalp was found in the right parietal region. There were no laceration of the scalp, fracture of the skull or cortical laceration or hemorrhage. In the white matter of both cerebral hemispheres and in the basal nuclei near the floor of the lateral ventricles were a few areas of punctate hemorrhages. The rest of the body showed no pathologic conditions.

CLINICAL STUDIES

One of us (C. C. B.) has studied a series of clinical cases of injury to the head accompanied by concussion, in which we think that the trauma was the etiologic factor giving rise to varying clinical syndromes; we wish to emphasize the importance of careful neurologic examinations in every case of concussion and to call attention to the importance of these late clinical states from a medicolegal standpoint.

REPORT OF CASES

CASE 10.—*History.*—W. T., a plumber, aged 35, single, had always been well. He had been operated on for hernia ten years before. He had apparently been in good health when he came to the United States from Ireland, five months prior to the accident.

Injury.—On Oct. 29, 1926, while at work, the patient was knocked down by a concrete building block falling on the top of his head. He was unconscious and was given prompt medical aid; he regained consciousness while a physician was sewing up the scalp. There was an interparietal wound of the vertex, about 4 inches (10.16 cm.) long. He was taken to St. Michael's Hospital, Newark, N. J., from which he was discharged the next day at his own request. He complained only of headache. The pulse, temperature and respiration were normal, as were the urine and blood pressure. Roentgenograms of the skull were normal.

Course.—After discharge from the hospital, the headache continued. A few days later, he had an attack of dizziness. He reentered the hospital on Nov. 8, 1926. The next day, ophthalmoscopic examination gave normal results. The

vision was: right eye, 20/20; left eye, 20/70. There was paresis of the left external rectus. A second set of roentgenograms of the skull were normal. On Nov. 30, in addition to the ocular palsy, there were: anesthesia of the left cornea, flattening of the left side of the face, widening of the eye-slits, the left more than the right, and diminished hearing, more noticeable in the right ear. The left knee jerk was a little more active than the right. The abdominal and cremasteric reflexes were normal.

Examination.—On Jan. 8, 1927, the patient had attacks of vertigo, a feeling of falling forward, disturbed sleep and a pulsating headache at night. There was gradual progressive loss of vision in the left eye and partial loss in the right eye. Vision was: right eye, 25/200; left eye, nil. The right visual field was markedly contracted for form and color. There was an apparent paralysis of the right external rectus. The retinal vessels were slightly tortuous, and there was slight pallor of the left optic disk. The pupils were normal. He heard only a shouting voice in the right ear. A Weber test was referred to the left ear.

Fig. 4 (case 10).—Patient in repose. The tilting of the head to the right, loss of expression in the left side of the face, widening of the left palpebral fissure and furrowing of the right eyebrow should be noted.

The vestibular reactions were practically normal; cold caloric stimulation in the right ear showed a diminished response. There was no spontaneous nystagmus. The tympanums were normal.

Second Examination.—On April 28, 1927, there were: a slight Romberg sign, active reflexes and past pointing inward with both hands. There was twitching of the right side of the face and contraction of the left occipitofrontalis muscle. The pupils were normal. Ophthalmoscopic examination showed tortuosity of the veins of both eyes and slight pallor of the left disk. There was left corneal anesthesia. He was deaf in the right ear but heard the speaking voice in the left. Rotation tests were normal. The calor test showed that the right ear responded promptly but was followed by severe nausea and symptoms of collapse.

Course.—He had recently developed: a jerky respiration; cyanosis of the hands; tilting of the head to the left; weakness and loss of expression in the

right half of the face; a bilateral von Graefe sign, more marked in the left eye; constant tremor of the head and neck, and uncertainty of gait and station. Examinations of the blood and spinal fluid gave negative results. Wassermann tests were negative. The basal metabolism rate was plus 8. There was no enlargement of the thyroid. The general physical examination gave negative results.

Summary.—Following an injury of the head without fracture of the skull, with headache as the only symptom after a short period of unconsciousness, the patient gradually developed symptoms referable to the brain stem. The optic nerves, the left fifth and sixth, the seventh nerves and the right eighth nerve were involved, as indicated by the tilting of the head, tremor, uncertainty of gait and station, disordered respiration and vasomotor changes. Careful study of the history in the case revealed no evidences of symptoms of epidemic encephalitis or other infective or degenerative disorder of the brain prior to the accident.

Case 11.—*History.*—A man, aged 39, married, a pipe fitter, whose family history was without significance, had always been in good health.

Injury.—On Sept. 13, 1926, he slipped and fell from a platform, 20 feet high, striking some pipes in his fall. He sustained a concussion of the brain, severe internal injuries of the chest and abdomen, contusions of the right shoulder and a hematoma in the back of the scalp. He was removed to the hospital. Roentgen examination of the skull and chest revealed no fractures. For ten days he was in a semiconscious state, with slight elevation of temperature, and a pulse rate from 100 to 110 and respiratory rate, about 30 per minute; after that they became normal. About October 19, when he was allowed to be up in a wheel chair, he had headache, vertigo and weakness. Sudden changes of position produced more or less vertigo. On lying down he complained of a dizzy, swaying feeling. These symptoms gradually lessened but never completely left him. On October 29, he was discharged from the hospital.

Course.—The patient was excitable. Respiration was quickened during examination or excitement. There was loss of superficial sensibility and diminution of deep sensibility on the right side of the body.

First Examination.—On April 28, 1927, examination revealed that the patient was strongly built and muscular, about 5 feet 3 inches (160 cm.) tall, and about 170 pounds (77.1 Kg.) in weight. There were slight scars in the right occipital and left post-temporal regions. He presented parkinsonian symptoms. The facial expression was masklike; the head and back were bent forward, and the hands were held in front of the body with the arms slightly flexed at the elbows. The right palpebral fissure was slightly larger than the left. The pupils were active. The left fundus oculi showed decided retinal edema, blurring of the margins of the disk and enlargement of the veins; the right fundus oculi showed engorgement of the veins but no other changes. A von Graefe sign was present bilaterally, and more marked on the right. The ocular movements were poorly coordinated and jerky; nystagmoid movements were present at both extremes of movement. The postural change was more marked on the right side. There was a fine tremor of both extremities, more marked on the right. The head was tilted slightly to the left and the chin turned to the right. The whole neck appeared shortened. The right scalene muscles were more tense than the left. The cervical spine was lordotic and the dorsal kyphotic. Voluntary innervation of the facial muscles on the right side was weak, especially in the lower half of the face. The respirations were jerky, 26 per minute, and the inspirations were frequently short and jerky. At times, there was a tendency to Cheyne-Stokes breathing. The reflexes of the upper extremities and the abdominal, cremasteric

and achilles reflexes were normal. The knee jerks were moderately increased. There was tenderness over the spinous processes of the fifth and sixth dorsal vertebrae. If he turned his head to the right, he lost his balance and fell. If he looked up, he became dizzy and lost his balance. Both hands were cyanotic. He complained of pain at the base of the skull and the upper part of the neck, and constant tinnitus in the right ear.

Second Examination.—On May 26, 1927, the blood pressure was 140. Since the first examination, the patient had shown no improvement. The eye-grounds and pupils were about the same. The innervation of the right side of the face was paretic. There were jerky movements of the eyeballs on fixation. The facial expression and posture were unchanged. Sudden turning of the head to the right brought on dizziness, suffusion of the face, irregular, jerky, difficult breathing and some degree of cyanosis. He said that at times "light stars" passed from the right to the left in front of the eyes. At times it seemed as if "somebody throws something across the face." He was startled by sudden talking behind him. When he lay down he had a feeling of swaying or bobbing up and down as if he was on a boat. Walking a short distance brought on an attack in which he felt as if his head was swelling and "all the houses on the street appear as if they are one." This sensation passed off after a few minutes' rest.

Otologic Examination.—The tympanums were slightly sclerotic in appearance. Right and left air conduction was 40/50 and right and left bone conduction, 25/30. He could hear a watch at 6 inches on the right and at 18 inches on the left. The Weber test was referred to the left. There was no reduction in the upper tone limits, but there was slight reduction in the lower. Past-pointing was normal. The vestibular apparatus, the cochleas and the auditory nerves apparently functioned normally. The slight reduction in conductivity was due to catarrhal changes in both ears.

CASE 12.—*History.*—H. D., a shipping clerk and boxer, aged 22, had always been in good health, but had received many blows on the head and face while boxing.

Injury.—In March, 1922, he was hit on the head with a black-jack, and since had complained of headaches, which had increased in intensity.

Course.—Nine months later, he began to develop inability to keep the eyes open, with a slow stuttering speech, stumbling gait, fixity of facial expression, tremor of the fingers and hands, weakness of the arms and legs, and a typical parkinsonian posture. He was admitted to the Newark City Hospital on June 3, 1923, and was discharged on June 13, with a diagnosis of epidemic encephalitis. He was readmitted on July 25, and discharged on October 5, with the same diagnosis.

He was readmitted on Oct. 9, 1923, and discharged on December 2, with the diagnosis of post-traumatic parkinsonian syndrome. He was committed to the Essex County Hospital for the Insane on Oct. 9, 1926. About March, 1923, he noticed that he could not walk freely. His vision diminished gradually so that he could not read print. The muscular rigidity increased, and saliva began to drool from the mouth. In July, 1923, the visual fields were slightly contracted for color and form. Vision in the right eye was 10/120, and in the left eye, 10/200. He heard a watch at 3 feet with the right ear and at 2 feet with the left. There was internal strabismus. The protruded tongue deviated slightly to the left and was finely tremulous. The knee jerks were markedly increased, and there was a slight Babinski sign on both sides. Tremor of the hands, exaggerated abdominal reflexes and typical parkinsonian posture and gait were present. There was slight ataxia of the upper extremities. The pulse, temperature, respira-

tion, urine and blood pressure were normal; the Wassermann tests of the blood and spinal fluid were negative. On June 3, 1923, a definite Babinski reflex was noted on the right side.

Examination.—At the Essex County Hospital, on May 19, 1927, his condition was about as before. The right pupil was slightly larger than the left. There were jerky movements of the eyeballs on fixation. The eyegrounds were normal. The knee jerks were increased—the left 4 plus, and the right 3 plus. There was double ankle clonus, on the left more than on the right. The superficial reflexes were hyperactive. The speech, posture, tremor, facial expression, loss of associated movements, increased tonicity of muscles, most marked in the left radial group, and other symptoms were definitely parkinsonian. The patient was committed to the Essex County Hospital after several attempts at suicide. At the hospital he was irritable, depressed at times, emotionally unstable and impulsive, unreasonable in his demands and required a great deal of attention. The laboratory examinations showed: blood sugar, 200 mg., normal spinal fluid, normal urine, normal blood and negative Wassermann tests.

Fig. 5 (case 12).—Anterior view of patient, showing parkinsonian picture.

CASE 13.—*History.*—S. L., a man, aged 33, married, whose family history was negative for nervous or mental disease and epilepsy, was said to have had pneumonia in childhood and mumps while in the army. He denied ever having had fits, fainting attacks, convulsions or seizures of any kind.

Injury.—On March 21, 1925, while at work, he slipped and fell from a platform to a concrete floor about 12 feet below, striking his head. He was unconscious for three days, and was confused for about ten days after regaining consciousness. He was unable to remember what had happened to him or where he was. He remained in the hospital for three weeks.

Course.—He returned to work on May 7, when he had no complaints other than weakness and fatigue. He did light work for a few weeks and then resumed his regular work until Oct. 27, 1925, when he suddenly fell from a chair, was unconscious and had a general convulsion. He was unconscious for about five minutes; the tongue was bitten, and he slept for several hours after the seizure. On December 6, he had a similar but more violent convulsion. After that he had more than fifteen seizures in which the period of unconsciousness lasted from two minutes to half an hour, and which were followed by mental confusion and stupor. None of the attacks were preceded by an aura.

Examination.—On June 8, 1926, there were: a slight grayish pallor of the temporal halves of both optic disks, inequality of the pupils, the right being larger than the left; the knee jerks increased, the left 3 plus, the right 2 plus; a left Oppenheim but no Babinski sign; right plantar reflex absent. The abdominal reflexes were diminished. There was horizontal nystagmus on both sides, more marked when he looked to the left. The tongue was coated, and had been bitten on the left side. The blood pressure was 128 systolic and 72 diastolic.

Subsequent Course.—The patient was in the New York Neurological Institute from Oct. 19 to 25, 1926, under the care of Dr. L. B. Chaney, to whom we are indebted for the following information: The general neurologic examination gave negative results except for the following: slight pallor of the temporal sides of both disks, not beyond physiologic limits, and the right pupil larger than the left. The mental and emotional state was normal. A routine blood examination, including a Wassermann test, gave negative results. The spinal fluid was normal, including a Wassermann test. Urinalysis gave negative results. A roentgen examination of the skull showed that the calvarium was normal and the pineal gland calcified. The sella turcica was normal. There was no evidence of a fracture. "During the patient's stay in the hospital two attacks were observed. On October 21, at 7:35 a. m., while eating breakfast, the patient suddenly gave a scream and fell from his chair unconscious. He regained consciousness at 7:55 a. m. The attack, which was observed during its entire course by the floor nurse and the resident house physician, consisted in a generalized tonic convulsion followed by clonic movements in all the extremities. The neck and head were thrown back in a tonic convulsive movement, and skew deviation of the eyes was present. The pupils did not react and the deep reflexes were absent."

"On October 24, the patient had another attack at 10:08 a. m., and was unconscious until 10:35 a. m. He again had a classic epileptic convulsion; first, generalized rigidity, followed by convulsive movements of the tongue, face muscles, head and all extremities. He bit his tongue, was markedly cyanotic and passed urine involuntarily. The pupillary, knee and ankle reflexes were absent. No aura preceded the attack. He was drowsy after the spell and slept for an hour or so."

Dr. Chaney was of the opinion that the man had had numerous minute intracranial hemorrhages at the time of the accident, and that the seizures were really epileptic. Under his treatment with dietary regulation, phenobarbital, etc., the man was free from attacks for several weeks.

Since he lived in New Jersey, he was sent back to one of us (C. C. B.) for continuation of the treatment on March 31, 1927. On May 10, at about 6:00 p. m., he awoke after a short nap and had a seizure. It was preceded by a peculiar, indescribable feeling for a second or two. He awoke an hour or so later and could not recall what had occurred. On May 13, there were: slight widening of the palpebral fissures, a von Graefe sign, more marked in the right eye, and nystagmoid movements when he looked upward and also to the left.

Case 14.—*History.*—C. B., a laborer, aged 23, single, had always been well except for occasional headaches. In December, 1918, he had influenza. He joined the army in 1919, and was discharged about nine months later for enlisting under age. He remained in good health.

Injury.—In August, 1920, the man was in a motorcycle accident. He sustained an injury to his head and was unconscious for about two hours. He was taken to St. Michael's Hospital, where a diagnosis of concussion of the brain was made. Roentgenograms showed no fracture of the skull. He was discharged from the hospital after four days, and then spent a week in bed at home.

Course.—He suffered from headaches and constant throbbing sensations in the head. In 1924, he underwent an operation on a frontal sinus, which relieved the headaches but not the throbbing in the head. In 1926, he was in another automobile accident. He was not injured, but was greatly excited. The right arm became shaky, and he could not write. Thereafter, he gradually developed rigidity of the right side of the body. He was admitted to the Newark City Hospital on Aug. 4, 1926. Roentgen examinations of the skull and chest gave negative results. A Wassermann test was negative, and a blood count was normal. Two basal metabolic ratings showed plus 20 and plus 36. The ocular movements were normal except for slight lateral and rotary nystagmus. On Jan. 3, 1927, the following were noted: a fine tremor of the right upper extremity; a double von Graefe sign, more marked on the right; a slightly enlarged thyroid gland; a normal pulse rate, and blood pressure averaging 140 systolic and 70 diastolic. The right side of the face was flattened and expressionless. Voluntary innervation of the face was normal. The entire right half of the body was rather stiff and rigid. The head was tilted to the right, and the chin pointed upward and to the left. The patient was able to correct this posture by a voluntary effort. The right shoulder was lower than the left. There were jerky movements of the eyeballs and a fine fibrillary tremor of the tongue with excessive salivation. The right half of the tongue was somewhat atrophied. Speech was stuttering, especially under excitement. The movements of the right upper and lower extremities were awkward and slow. Voluntary effort produced occasional jerky movements of the right arm. He favored his left hand. The left side of the body was normal. The knee jerks were sluggish, but reacted well on reinforcement. The abdominal and cremasteric reflexes were normal. There was no Babinski sign, no clonus and no loss of any form of sensibility. There was an increase of lumbar lordosis. Respiratory rhythm was increased on slight exertion. There were no Romberg sign, no ataxia, no spontaneous nystagmus and no past-pointing. The pupils and vision were normal. The visual fields were normal on gross examination. Ophthalmoscopic examination gave negative results. There was no corneal anesthesia. Bárány tests gave normal responses. The external ocular muscles were normal when tested with a phoroptor. The patient had lost no weight during the preceding year. He stood well on the left heel or toe. He fell backward or forward when he stood on the right heel or toe. He fell backward when he stood on both heels with the feet together. He stood fairly well on the toes. Voluntary innervation of the face was normal.

SUMMARY AND CONCLUSIONS

1. Injuries of the head with slight or no evidence of other external injuries are followed in a certain percentage of cases by death or by clinical symptoms indicating structural damage to the deeper parts of the brain.

2. The damage to the brain consists of minute, multiple, punctate hemorrhages distributed chiefly in the areas supplied by the terminal branches of the central ganglionic system of vessels. They are also occasionally found in the centrum ovale, which is supplied by the long medullary arteries of the cortical system. They are rarely seen in the cerebral cortex or below the tentorium cerebelli.

3. The frequency of these hemorrhages in the basal ganglia is thought to be due to a contrecoup effect on the cisterna interpeduncularis with consequent jamming back of fluid into the perivascular spaces.

4. In our series, the incidence of this type of injury was almost 3 per cent, a much higher percentage than that reported by Cassasa.

5. Microscopically, these hemorrhages are seen to surround the vessels, filling the Virchow-Robin spaces in a "ringlike" manner. This appearance, however, is not pathognomonic of trauma, as it is also seen in arsenical encephalitis, fat embolism and the hemorrhagic forms of influenzal encephalitis.

6. The mechanical theory of concussion advanced by Cassasa appears to be the best explanation of the causation of these hemorrhages.

7. Since it is claimed that similar lesions may be caused by fat embolism, especially in injuries of the head associated with fracture of the long bones or extensive traumatism of the panniculus adiposus, the question of fat embolism should be considered carefully in every case, and if possible eliminated by proper technic at necropsy and thorough histologic study.

8. We believe that multiple concussion hemorrhages may explain many of the sequelae of cranial injuries. The clinical picture, varying with the location and extent of the lesions, may resemble that of paralysis agitans, of disseminated sclerosis, of progressive lenticular degeneration or of chronic epidemic encephalitis.

9. Every case of injury to the head should be considered serious, and the patient should receive careful neurologic examination and observation, as an apparently trivial head injury may be followed by grave results and may be of great importance to civil and workmen's compensation courts in the estimation of disabilities and the assessment of damages.

HOMOLATERAL INVOLVEMENT OF THE PYRAMIDAL TRACT IN CEREBRAL TUMORS

REPORT OF A CASE *

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The occurrence of homolateral involvement of the pyramidal tract in infratentorial tumors is not rare. Thus Gould,[1] in an analysis of 50 cases of tumors of the posterior fossa, reported homolateral increase in tendon reflexes in 27, 16 of which were lateral recess growths and 11 intracerebellar tumors. This author did not find any discoverable relation between the size and location of the growth and the occurrence of changes in tendon reflexes; nor was there any parallelism between the degree of ventricular distention or papilledema and involvement of the cranial nerves on the one hand, and disturbances of the pyramidal tracts on the other. Gould explained the occurrence of homolateral involvement of the pyramidal tract by "contrecoup" pressure of tumors exerted on the contralateral pyramid which fits snugly against the basioccipital bone.

The occurrence of homolateral signs of the pyramidal tract in supratentorial tumors is not so common, and there is scarcely any literature on the subject. Thus, Oppenheim [2] regarded this symptom as being extremely rare and usually due to an error in observation such as an overlooked lesion in the opposite hemisphere or in the brain stem (hemorrhage, edema, softening, etc.) which implicated the pyramidal tracts. He believed, moreover, that processes arising from one hemisphere, especially tumors, may press so much toward the other hemisphere that it suffers chiefly from compression. In rare cases the homolateral involvement was ascribed to a defect of development such as congenital failure of the decussation of the pyramids.

James Collier,[3] in a review of over 100 cases of verified supratentorial tumors, found bilateral spastic paresis in several cases associated with considerable distention of the ventricles. In only one of his series

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* From the service of Dr. T. H. Weisenburg, Graduate School and Hospital of the University of Pennsylvania.

1. Gould, Edward M.: Tumors of the Posterior Cranial Fossa, Arch. Neurol. & Psychiat. **19**:509 (March) 1928.

2. Oppenheim, H.: Lehrbuch der Nervenkrankheiten, Berlin, S. Karger, 1923, p. 1049.

3. Collier, James: The False Localizing Signs of Intracranial Tumors, Brain **27**:490, 1904.

of cases was there a homolateral involvement of the pyramidal tract with a tumor of the right optic thalamus, but this was associated with extensive thrombosis of the anterior branches of the left sylvian artery. He gave warning of the not infrequent production in tumors of the brain of "false localizing signs" by the presence of vascular lesions, meningitis, hydrocephalus, local spreading edema, etc. This author stressed the frequent occurrence, as demonstrated post mortem, of deep indentation of the crura cerebri by the free edge of the tentorium.

Purves-Stewart [4] cited a case in a man, aged 37, with focal signs comprising a left facial weakness, together with paresis of the right arm and leg, for whom a diagnosis of a left-sided pontile lesion was made. A cerebellar decompression revealed a large medullary cone but no tumor. At autopsy, a large cystic area, about 3 inches (7.62 cm.) in diameter (mixed cell sarcoma), was found in the lower half of the right precentral area. The subjacent convolutions were deeply depressed beneath the surface and distorted by the contents of the cystic growth.

Woltman [5] reported a case of Dr. W. Kernohan in a man, aged 47, who was admitted with mental deterioration and convulsions. The latter were more marked on the left side, and a Babinski sign was noted on this side. A diagnosis of a right-sided frontotemporal tumor was made. At necropsy, a tumor of the left frontotemporal lobe was found. The brain was displaced upward and to the right—a massive displacement of both cerebral hemispheres and of the upper part of the brain stem. The falx cerebri and the tentorium being relatively rigid structures, the displacement of the brain stem brought the convex portion of the right pes pedunculi against the edge of the tentorium. This edge caused an indentation in the pes, which was well marked. It was considered that the notching of the peduncle was sufficient to interrupt some of the fibers (right corticospinal) and caused the positive Babinski sign on the left side (after decussation).

Groeneveld and Schaltenbrand [6] described a case in a man, aged 43, which commenced with jacksonian epilepsy of the right side of body, later developing into a left-sided spastic hemiplegia, and which from the start showed general evidences of a tumor of the brain. At autopsy, there were found a dural endothelioma over the left sylvian fissure, considerable edema of the left hemisphere and an indentation of the

4. Purves-Stewart, Sir James: Intracranial Tumors and Some Errors in Their Diagnosis, New York, Oxford University Press, 1927, p. 20, case 5.

5. Woltman, H. W.: Incisura of the Crus Due to Contralateral Brain Tumor, Proc. Staff Meet., Mayo Clin. **3**:69 (March 7) 1928.

6. Groeneveld, A., and Schaltenbrand, G.: A Dural Endothelioma over the Cerebral Hemisphere with Lesion of the Contralateral Pes Pedunculi Through Pressure Against the Edge of the Tentorium, Deutsche Ztschr. f. Nervenh. **27**: 32, 1927.

right pes pedunculi produced by pressure against the free edge of the tentorium. On microscopic examination, the indentation revealed an area of necrosis with remains of old and recent connective tissue organization. The authors elucidated the anatomic relationships of the crura and the tentorium which are responsible for the production of this unusual sign: A process of dura extends from each anterior clinoid process to the free edge of the tentorium, which together with the falx renders the tentorium resistive. The edge of the tentorium, which forms the hole in the dura called the superior occipital foramen through which the midbrain passes, is about from 40 to 50 mm. long and about 35 mm. wide, so that the peduncle fits closely against an unyielding canal. Moreover, this canal lies in a nearly horizontal plane and just above it the two peduncles diverge, so that it can be stated that the tentorial aperture fits like a purse-string around the midbrain. It is not surprising, therefore, that any increased pressure from above should cause indentation of the relatively softer peduncle against the knifelike edge of the tentorial opening.

The occurrence of homolateral involvement of the pyramidal tract as a "false localizing sign" is well illustrated in the following case.

REPORT OF CASE

History.—M. H., aged 36, a high school graduate, a housewife, married, whose family and past medical history were without significance, was in good health until August, 1927, when she began to complain of pain in the left occipital and frontal regions. A diagnosis of sinusitis was made, but despite local treatment the pain became progressively worse. Her sister stated that, early in 1928, the patient developed spells characterized by a blank stare, grinding of the teeth and speechlessness. After such spells, she would sleep long and soundly. In April, 1928, she developed drooping of the left upper eyelid, and shortly after this painless vomiting, unsteadiness in gait, tremor of the right hand and numbness of both hands and feet appeared. The tremor of the right hand would disappear with sleep.

Dr. Robert Denison, who examined the patient in April, 1928, found ptosis of the left upper eyelid; the left pupil was 2 mm. larger than the right, both pupils reacting to light and in accommodation. There was bilateral choking of the disks. There was bilateral weakness of the upper and lower extremities, which was more marked on the left side. Despite a negative history for syphilis and a negative Wassermann reaction, bismuth, mercury and iodides were administered with temporary improvement in the general condition, and with diminution of the headache and of the ptosis of the left upper eyelid. In August, 1928, occasional vesical incontinence was observed and the patient developed considerable hiccup, drowsiness and thickness of speech. Early in September, 1928, weakness of the left side of the face with pronounced weakness of the left upper and lower extremities developed. She was admitted to the Graduate Hospital on Sept. 30, 1928.

Neurologic Examination on Admission.—The patient was emaciated, pale and in a generally poor physical condition. There was a quantitative intellectual

reduction manifested by impairment of memory for both recent and remote events, with partial disorientation and loss in the general fund of knowledge. Speech was thick, flat and monotonous, but there was no distinct aphasia either in the sensory or in the motor sphere. Perception of smell was normal. There was considerable reduction in acuity of vision without characteristic field changes; there was bilateral swelling of the disks, 5 diopters on the left side and 4 diopters on the right. The left upper eyelid was definitely weak, the right questionably so; both pupils were slightly irregular in outline; the left pupil was much larger than the right; both reacted well to light, both directly and consensually, and in accommodation and convergence. All extra-ocular movements were normal, with the exception of irregular, horizontal and nystagmoid movements. There was left-sided corneal anesthesia and questionable weakness of the left masseter muscle. The lower part of the left side of the face was distinctly paretic. There was no impairment of taste in either the anterior or the posterior part of the tongue. There was no diminution of hearing. The gag reflex was diminished. In addition to the difficulty with speech already mentioned, there was occasional difficulty in swallowing. The left upper and lower extremities were definitely paretic; the reading of the left hand by the dynamometer was 30; of the right, 50; she dragged the left foot in the typical way. There was no appreciable alteration in muscle tonus in any of the extremities. There was considerable wasting of the left upper and lower extremities, especially of the muscles of the left hand; no fibrillary tremors were observed. The tendon reflexes were bilaterally exaggerated but much more so on the left side; the abdominal reflexes could not be obtained; on the left side there was ankle clonus and a positive Babinski sign. The finger-to-nose, the heel-to-knee, and the succession tests were faulty on both sides, but much worse on the left side. The rebound phenomenon was not present. In walking, she tended to reel, falling most frequently to the left side. Sensation was normal for pain, temperature, touch, position, vibration and stereognosis. On extension at the elbows there was observed constantly a fine tremor of the fingers of the right hand. Dr. Lewis Fisher reported that Bárány tests indicated a supratentorial lesion. The roentgen examination of the skull revealed a depression of the middle fossa with flattening of the sella turcica and pronounced convolutional markings of the inner table.

Laboratory Observations.—All studies were essentially normal. There was a moderate secondary anemia. The urine and blood chemistry were normal. The Wassermann reaction of the blood serum was negative with all antigens. The performance of a lumbar puncture was considered inadvisable.

Course in Hospital.—After the patient was admitted to the hospital (Sept. 30, 1928), the condition became progressively worse; the left extremities became weaker (dynamometer: right hand, 50; left hand, 10), and she had greater difficulty in locomotion. She became incontinent; there was a rapid decline of mentality and a serious loss of visual acuity.

A diagnosis of a supratentorial tumor was made, some of the staff inclining to the diagnosis of a lesion in the third ventricle. An operation was decided on, favoring, in spite of the left hemiplegia, a left-sided approach in view of the early history of left-sided headaches, and the relatively early development of the weakness of the left upper eyelid.

Operation.—The operation, performed by Dr. F. C. Grant, on Oct. 13, 1928, resulted in surprising observations. Ventricular tapping revealed that the right ventricle contained 45 cc. of clear fluid, while the left contained only 15 cc. of yellowish fluid. This was followed by injection of air and immediate roentgen

examination. A bulging into the body of the left ventricle from before backward was noted. The patient was immediately returned to the operating room, a fronto-parietal flap was made and an endothelioma, the size of a small apple, was removed from the frontal end of the left sylvian fissure. The patient went into desperate shock, but with the aid of a blood transfusion and dextrose and insulin, made an uneventful surgical recovery.

After the operation, the patient developed aphasia with inability to carry out moderately complicated commands and difficulty in finding words to express herself. She also became rather euphoric. Almost from the beginning, however, there was diminution of the ptosis of the left eyelid and return of power to the left extremities. When discharged from the hospital on Oct. 28, 1928, the general condition was good, the palpebral fissures were equal, there was considerable power in both left extremities and a considerable improvement in speech, but she still showed euphoria and a considerable intellectual reduction.

COMMENT

The left-sided hemiparesis with a definite Babinski sign pointing to the existence of a right-sided lesion would have proved disastrous to the patient were it not for the definite localization obtained by the aid of the ventriculogram. Nevertheless, the history of the onset and persistence of left-sided headache and the relatively early appearance of ptosis of the left eyelid swayed me to the diagnosis of a left-sided lesion. This example emphasizes the importance of a carefully obtained, clear and complete history in the evaluation of neurologic conditions. Concerning the mode of the production of the homolateral involvement of the pyramidal tract in this case, no absolute explanation can be given, as the patient did not come to autopsy. Whether the condition resulted from the overdistended right ventricle (which is less likely) or from the displacement of the brain downward and by "contrecoup" pressure of the brain stem against the edge of the tentorium, must remain undetermined. The bilateral dyssynergia and the bulbar type of speech would point rather to the existence of pressure on the brain stem. Future investigation of similar cases will throw more light on the modus operandi in these interesting and important cases and may reveal a method of more accurate preoperative diagnosis.

SUMMARY

1. The occurrence in supratentorial tumors of homolateral involvement of the pyramidal tract is probably due to indentation of the pyramid against the relatively rigid edge of the tentorium. This "false localizing sign," because of practical importance, requires further investigation.

2. A case with left-sided hemiparesis due to a successfully removed left-sided endothelioma is presented.

3. The importance of a carefully obtained history and of ventriculography is illustrated in the handling of this case.

News and Comment

INTERNATIONAL NEUROLOGICAL CONGRESS

In response to preliminary communications sent out by the American Neurological Association, delegates representing twenty countries, composing the program-executive committee, met at Berne, Switzerland, on August 29 and 30 at the Hotel Bellevue-Palace, to take the necessary steps to organize the Second International Neurological Congress. This congress will take the place of the congress which was to have been held in Berne in 1914 but which was interfered with by the outbreak of the World War.

Dr. Sachs, the Chairman of the Organization Committee of the American Neurological Association, at the opening of the meeting presented the greetings of the American Organization Committee to the delegates from the various countries, who had assembled at Berne to prepare for the International Neurological Congress.

The delegates who were present, and the countries which they represented, were as follows: Prof. Otto Marburg and Prof. C. von Economo, Austria; Dr. L. van Bogaert, Belgium; Dr. Hubert Procháska and Dr. J. Šebek, Czecho-Slovak Republic; Dr. Knud H. Krabbe and Prof. August Wimmer, Denmark; Prof. H. Fabritius, Finland; Prof. Georges Guillain and Prof. Gustav Roussy, France; Prof. O. Foerster and Prof. M. Nonne, Germany; Sir James Purves-Stewart and Prof. S. A. Kinnier Wilson, Great Britain; Prof. B. Brouwer and Prof. K. H. Bouman, Holland; Prof. Ladislas Benedek and Prof. A. von Sarbó, Hungary; Prof. Ottorino Rossi and Prof. V. M. Buscaino, Italy; Prof. G. Fuse and Prof. T. Wada, Japan; Prof. M. Lapinsky, Jugo-Slavia; Prof. Dr. J. Piltz and Dr. W. Sterling, Poland; Dr. L. Ballif and Dr. St. Draganesco, Roumania; Prof. M. Kroll, Russia; Dr. B. Rodriguez Arias and Dr. M. Prados, Spain; Prof. Henry Marcus and Dr. Nils Antoni, Sweden; Prof. R. Bing, Prof. F. Naville and Dr. Charles Dubus, Switzerland, and Prof. B. Sachs and Prof. Henry Alsop Riley, United States.

The following officers were elected: president, Dr. Bernard Sachs, United States; vice-presidents, Prof. R. Bing, Switzerland; Prof. Georges Guillain, France; Prof. C. U. Ariëns Kappers, Holland; Prof. Otto Marburg, Austria; Prof. Max Nonne, Germany; Prof. Henry Marcus, Sweden; Prof. Ottorino Rossi, Italy, and Sir Charles Sherrington, Great Britain; secretary-general, Dr. Henry Alsop Riley, United States; recording secretary, Dr. Charles Dubois, Switzerland, and assistant recording secretary, Dr. von Fischer, Switzerland. The choice of treasurer and assistant treasurer was left to the Swiss Neurological Society. For the present all funds collected shall be sent to Dr. Charles Dubois in Berne, Switzerland. Prof. B. Brouwer, Holland, was elected as editor of the transactions, and Prof. S. A. Kinnier Wilson, Prof. Gustave Roussy, Prof. C. von Economo and Prof. V. M. Buscaino as assistant editors. The assistant editors represent the four official languages: English, French, German and Italian, respectively. The Committee may add other members whenever they deem it necessary. A paid nonprofessional registrar will be engaged by the secretaries of the Congress.

The honorary members are J. Babinski, Santiago Ramon y Cajal, Henry Head, S. E. Henschen, Wagner-Jauregg, Pierre Marie, Charles K. Mills, Constantin von Monakow, Kinnosuke Miura, Ivan Petrovic Pavlov, M. Allen Starr, E. Tanzi and C. Winkler. This list is not considered complete; further additions will be made from time to time.

Thos. Cook and Son will be the official transportation agents for members of the Congress in 1931. The housing and accommodations in Berne will be left to the local Committee. Those who plan to attend the Congress should write to the local committee in care of Dr. Dubois.

The social functions of the congress will be arranged by the Swiss Committee. Prof. R. Bing expressed his willingness to assume the rôle of the official publicity representative of the congress and to transmit official statements to the general press.

The matter of subscriptions was left to the discretion of each country or of each group of neurologists. The countries which can do so will try to raise a minimum of 500 Swiss francs in each of the years, 1930 and 1931.

The congress will be essentially neurologic, but psychiatric conditions which have a somatic basis may be discussed at the sessions. There will be morning and afternoon sessions on Monday, August 31, Tuesday, September 1, Thursday, September 3 and Friday, September 4. Wednesday, September 2, will be observed as a holiday; appropriate excursions will be arranged by the Swiss Committee. No scientific sessions will be held in the evening. Definite topics will be selected for the morning sessions and will be followed by discussion; the afternoon sessions will be devoted to short original contributions. The topics of the miscellaneous papers may be of any nature so long as they are in the general field of the congress. The final choice of the papers will be left to the program committee. Presentations are not to exceed thirty minutes and if possible are to be spoken and not read. So far as practicable, abstracts of the material to be presented will be furnished to the members of the congress. If a member cannot speak in one of the four official languages, he will be permitted to read his presentation in one of the official languages. Discussion by an individual member will be limited to ten minutes. All contributions to the scientific sessions of the program must be in the hands of the program committee by Feb. 1, 1931.

The titles chosen for the symposia are as follows:

1. "Diagnostic and Therapeutic Procedures (surgical and otherwise) in Brain Tumors." Morning and afternoon sessions of the first day; program to be arranged by Professor Nonne. Reporters (tentatively suggested): Cushing, Trotter, Vincent, de Martel and Foerster.

2. "Muscle Tonus: Anatomy, Physiology and Pathology." Morning session of the second day. Program to be arranged by Sir Charles Sherrington. Reporters (tentatively suggested): von Economo, Ramsay Hunt, Rademaker, Wilson and Thévenard.

3. "Acute Nonsuppurative Infections of the Nervous System." Morning session of the third day. Program to be arranged by Professor Guillain. Reporters (tentatively suggested): Marburg, Buscaino, Greenfield, Marinesco, Pette, Andre Thomas, Van Bogaret and Wimmer.

4. "The Rôle of Trauma in the Production of Nervous Symptoms." Morning session of the fourth day. Program to be arranged by Professor Rossi. Reporters (tentatively suggested): Charles Symonds, Del Rio Hortega, Lhermitte, Jelliffe, von Sarbó and Veraguth.

As far as possible, one of the vice-presidents will preside at each session. The president, vice-presidents and secretaries will constitute a committee with power to act on the further elaboration of the program.

The question of the formation of a permanent International Neurological Association was brought up for discussion, but it was decided to have this taken up at the congress and that the definite question to be submitted to the constituent associations was "whether there shall be a definite International Neurological Association with distinct functions of its own or whether there shall be a mere union of neurological associations which would arrange subsequent meetings from time to time." Professor Brouwer of Holland read a communication from Professor Henschen of Sweden who urged the formation of a Brain Commission; but it was believed that the organization of such a commission was also the responsibility of the congress.

Professor Nonne spoke on behalf of the delegates and expressed his appreciation and thanks for the preparation of the meeting by the American Committee. He proffered special thanks and congratulations to the president, Prof. Bernard Sachs.

Professor Sachs brought the meeting to a close by expressing his appreciation of the great honor done him and pledged his efforts and those of workers associated with him to the preparation of a happy and successful meeting in 1931.

MORTON PRINCE, M.D.

1854–1929

Obituary

MORTON PRINCE, M.D., LL.D.
1854–1929

In the death of Dr. Morton Prince, which occurred on Aug. 31, 1929, America has lost one of its most versatile and original neurologists. He died at the Peter Bent Brigham Hospital, where he had gone for treatment, primarily for his heart, and although some hope had been entertained that he might recover in spite of his advanced age of 74, his strength proved unequal to the demand.

He was born in Boston on Dec. 21, 1854, the son of Frederick O. Prince and Helen Susan (Henry) Prince. His father was active in politics, was at one time mayor of Boston and ran for governor on the Gold Democratic ticket in 1896. He was also secretary of the Democratic National Committee for a number of years. The strong political leanings which Dr. Prince had throughout his life no doubt are largely accounted for by his father's career and example. He was prepared for college at the Boston Latin School, was graduated from Harvard in 1875, and from the Harvard Medical School in 1879. After serving as intern in the Boston City Hospital, he spent a year of study in Europe. On his return to Boston, he began the practice of his profession which continued uninterruptedly until the end of his life. He married Miss Fanny L. Payson, of Salem, Mass., in 1885. His wife and a son and daughter, Morton P. Prince and Mrs. Claire M. Walcott, survive him.

During the first years he devoted himself particularly to diseases of the nose and throat and had appointments both at the Boston Dispensary and at the Boston City Hospital. He early became interested in the nervous system and soon identified himself with neurology. For many years he was one of the physicians in the Department of Nervous Diseases at the Boston City Hospital, associated with Dr. William N. Bullard and Dr. Philip Coombs Knapp. He resigned from the City Hospital in 1913. For three years, from 1895 to 1898, he was instructor in neurology at the Harvard Medical School. In 1902 he accepted the position of Professor of Nervous Diseases at the Tufts College Medical School and taught continuously for ten years, thereafter being appointed Professor *Emeritus*. Teaching was, however, by no means his main interest. He, no doubt, begrudged somewhat the time required for this purpose and found greater satisfaction in writing and in the development of his theories.

Although never neglectful of medicine as his chief object, he found time for many other pursuits in which he had much satisfaction. He was United States Examining Surgeon for Pensions from 1885 to 1888. He gave a series of lectures at the University of California in 1910 on "Abnormal Psychology" and in 1924 lectured in London, Oxford, Cambridge and Edinburgh. When the World War broke out he forthwith became active in promoting the cause of the Allies. In 1915, he was chairman of the Serbian Distress Fund and was at the head of the Reception Commission in Boston for the Japanese Mission in 1917 and for the Serbian Mission in 1918. From 1914 to 1917 he was prominent in organizing propaganda for the cause of the Allies, visiting England, France and Japan for this purpose. For this service he was decorated with the Orders of the Chevalier of St. Saba, The Royal Order of the Red Cross and the Order of the White Eagle by Serbia, the Order of the Rising Sun by Japan and the Cross of the Legion of Honor by France. In 1916, he organized the "Address of the Five Hundred Americans to the People of the Allied Nations." He was furthermore manager of the Massachusetts Sailors and Soldiers Information Bureau in Paris and a major in the Massachusetts Home Guard. This sort of work he did well and it gave full scope to his organizing capacity and his vision regarding matters of public policy. It should further be noted that in more local movements he was at one time secretary of the Public Franchise League of Massachusetts, chairman of the Committee of One Hundred for the Adoption of the Boston Charter and chairman of the Boston Charter Association. He was for many years connected in an official capacity with the Boston Police Department. His aptitude for writing on matters apart from his profession led to his appointment as a special correspondent for the Boston Herald at the Paris Peace Conference during the years 1918 and 1919.

It was natural that a man of his catholic tastes and wide attainments should hold membership in many learned societies and social clubs. He was a constant attendant at medical meetings and rarely failed to take part in the discussions, in which he was always ready to see the point of view of others while consistently maintaining his own. He was never unfair in debate, however strongly he may have felt the error of those who disagreed with him. He belonged to the Association of American Physicians, to the American Neurological Association, of which he was president in 1910, to the American Psychopathological Society, to the Association for Research in Nervous and Mental Diseases, in which he took an active interest, and to many other organizations of a more local character. He was a member of the Century Association of New York and of various clubs in Boston where his eminently social characteristics had ample scope. He was particularly devoted to the Tavern Club

and was a frequent contributor to its entertainments. His versatility was further shown by the fact that he was an enthusiastic horseman and ardent yachtsman. Within a year or two of his death he had a somewhat narrow escape from serious injury when he was thrown from a horse, but this accident, although disabling for a time, probably had nothing to do with the development of his final illness. As a member of the Eastern Yacht Club he took part in various races sponsored by that club and enjoyed the sea as he did everything else.

All these activities were, however, side issues in a life which was primarily devoted to the fundamental problems relating to the mind and nervous system in which he was distinctly one of the American pioneers. Wide as his field of interest was, he will be known in the future primarily for his contributions to psychopathology and for his indefatigable enthusiasm in promoting its ends. One of his earliest contributions, written when he was about 30 and published in book form under the title "The Nature of Mind and Human Automatism," gives definite indication of the path along which he was to go in the succeeding years of his long life. Published in 1885, when discussion was active regarding the materialistic conception of mental phenomena and the materialistic point of view in general, it took no little courage to set forth his somewhat radical thesis. He attacked vigorously the dominant theologic attitude and at least made out a fairly strong case for a materialistic conception. His chapter on "The Reflex Character of Ideas" foreshadows the importance which has since been attached to reflex mechanisms and the conditioned reflex in general. This book, now probably largely forgotten, is well worth reading as an indication of the trend of thought forty-five years ago and shows how clearly Prince foresaw what was to come. He concluded the book with the following paragraph: "Theological ethics is that best suited for the control of man as he now exists. Whether mankind will in the future attain to a degree of development which will enable the individual to perform a duty for duty's sake, without hope of reward or fear of punishment, is a question which belongs to the domain of speculation. At present, however humiliating may be the thought, man, like the brute, can only be tamed and morally educated by the alternate use of sweetmeats and the lash."

Articles on varied subjects, not wholly medical, and books followed in a constant stream. Among the more notable of his contributions should be mentioned "The Dissociation of a Personality," 1906; "The Unconscious," 1914; "The Psychology of the Kaiser," 1915; "The Creed of Deutschtum," 1918, and "Clinical and Experimental Studies in Personality," published in Cambridge the year of his death. Certainly the most notable of these books was the "Dissociation of a Per-

sonality," which he called a biographic study in abnormal psychology. Had he written nothing else this book would have placed him in the front rank of psychologic students. It is the history of a single individual and the study of the different personalities which he was able to produce by hypnotic means. The complex subject of dissociated personality is presented in an extremely entertaining and not overtechnical fashion. The interest which this work aroused did much toward placing on a scientific basis the whole complex problem of human personality. "The Unconscious" with a subtitle "The Fundamentals of Human Personality Normal and Abnormal" is a thick volume of 542 pages in which are reviewed the theories of others together with his own conclusions regarding this much discussed psychologic hypothesis. In it he introduced the term "co-conscious," supplementing the more commonly used "subconscious," and thereby brought a certain clarity into this obscure subject. In "The Psychology of the Kaiser," which is a study of the former Kaiser's "sentiments and his obsession," he gives expression to his ideas regarding world problems of peace and arrives at the conclusion that the Kaiser subconsciously feared democracy for himself and for his House, and that therein lay the secret of his character. "If the Powers of Europe want lasting peace through the overthrow of autocracy and militarism, i. e., Germanism, the obsession of the Kaiser points the way—look to the democracy of Germany!"

Always interested in the development and dissemination of knowledge regarding his favorite subject, he conceived the idea of founding a special journal, the first number of which appeared in April, 1906, under the title *"The Journal of Abnormal Psychology"* later enlarged to include social psychology, with the leading article by Dr. Pierre Janet. This publication, the need of which was perhaps doubted in certain quarters, has been uninterruptedly published since its inception and has filled an increasingly important place in the literature of the subject. To this periodical, naturally, Prince himself was a frequent and an illuminating contributor. Apart from his more ambitious literary work, to which allusion has already been made, he published in various journals approximately 100 original papers on general medicine, forensic medicine, neurology, psychiatry, psychopathology and even ventured into the realm of philosophy. In fact, a reading of his contributions through the last forty years covers practically all the subjects which have been agitating neurologists and psychiatrists during that extremely active period.

On the occasion of his seventieth birthday he was presented a volume, to which many of his friends and colleagues in this country and abroad contributed, entitled "Problems of Personality." In the subheading of this book he was called a pioneer in American psychopathol-

ogy. This simple phrase expresses perfectly what he was and what he did in the field to which he primarily devoted his life.

In his early years, after his first interest waned in disorders of the nose and throat and in certain problems in general medicine—typhoid fever, heart disease, electrolysis—he published a number of papers on topics relating to organic neurology, but even then he showed his predilection for functional disease and many of his early papers foreshadowed his strong psychologic trend, which was to become more dominant in later years. His significant work was obviously in the field of psychopathology and when his other contributions are forgotten this will doubtless remain as a positive and lasting contribution to knowledge in an increasingly important field. Any adequate evaluation of the mass of material which he worked over and published is beyond the scope of this notice, but it may fairly be said that it played a conspicuous part in exciting general interest in a little understood and therefore unpopular subject, in overcoming prejudice and in advancing the day when psychopathology will occupy as dignified a place in the medical curriculum as pathology of the structural type.

The last academic appointment he held was an associate professorship of Abnormal and Dynamic Psychology in the Harvard Department of Philosophy and Psychology. In the years from 1926 to 1928 inclusive, with the assistance of Dr. Henry A. Murray, who is continuing the work, he established a laboratory and clinic in Cambridge where, independently of the medical school, he carried on his researches. This appointment, late as it was in coming, he regarded as his crowning achievement, an acknowledgment of his belief that psychopathology should have a place in the academic course, open to undergraduate as well as to graduate students.

If one were asked to select a single outstanding characteristic of Prince's personality, one might well choose versatility. He was a many-sided man, and devoted his entire energy to what he was doing at the moment, whether riding, yachting, dining or talking on one of his favorite psychologic topics. He was a charming host and a good sportsman in every sense of the word. Personally, he was genial and always considerate of others; he was entirely lacking in aloofness and an attitude of superiority, qualities which not infrequently accompany exceptional attainment. He enjoyed giving expression to his views on all occasions, and at medical meetings was frequently on his feet taking part in discussions which were, on his part, never acrimonious. In this respect he was an excellent controversialist, with strong convictions but an unruffled temper under whatever provocation. Even when such a red rag as the popular spiritualism was flaunted before him, he maintained a reasonable degree of calmness and good humor and enjoyed the

dispute. He was a devotee of sport and never a cloistered student such as one might expect from his literary accomplishment. His life was packed full of interests, diverse in kind, but all permitting and promoting the expression of his really protean personality. With all this went a peculiar kindliness and generous, totally unpatronizing interest in the welfare of others less gifted than he. Above all he was broad-minded and liberal in his attitude, a quality which particularly distinguished him, next to his extraordinary versatility. His attitude toward the freudian doctrine, for example, was critical in the extreme, and even unsympathetic, but he nevertheless ungrudgingly acknowledged the fundamental contribution Freud had made and gladly incorporated it in his own psychologic scheme. He had a ready pen, as the volume of his published work attests. Such men as Prince are rare in any walk of life, and in the controversial atmosphere of psychologic theory they are invaluable. He enjoyed life to the utmost in all its varied phases. His energy and industry were unflagging, and there was no falling off toward the end of his life in the alertness of his mind and the keenness of his intellectual interest. Fortunately, he had no long period of invalidism; he died in the fulness of his powers.

E. W. TAYLOR.

Abstracts from Current Literature

LUMLEIAN LECTURES ON EPILEPSY. JAMES COLLIER, Lancet **1**:587 (March 24); 642 (March 31); 687 (April 7) 1928.

The author's thesis is: That the clinical phenomena met with in idiopathic epilepsy, in epilepsy from local lesions of the brain, and in symptomatic epilepsy occurring in disordered metabolic states in general diseases and intoxications are identical and are truly indistinguishable; that those occurring in narcolepsy, migraine, vasovagal attacks, idiopathic syncopal attacks, and perhaps also in tetany, are phenomena of the same order and are closely allied to those of epilepsy with which they occasionally mix; that there is one pathologic factor which is common to all these conditions; this is hypothesized as a metabolic dyscrasia, the nature of which is not always the same, and therefore different clinical syndromes occur in which the prognosis varies.

After a short review of the experimental investigations and conclusions of several observers, the author offers the following clinical features of epilepsy as evidence of its metabolic origin: 1. Seizures usually occur at the periods of metabolic instability—early infancy, puberty and old age; they are associated with other metabolic disturbances such as rickets; the periodicity is more reasonably explained on the grounds of metabolic dyscrasia than on any other hypothesis. 2. Usually, epileptic women have complete immunity from attacks during pregnancy, as if faulty metabolism of the mother were corrected by that of the fetus. Such immunity may occur in "organic" epilepsy as well as in the idiopathic form. On the other hand, epilepsy may occur only during pregnancy, and with repeated pregnancies; this form, according to Collier, belongs to the class of eclampsias due to anaphylaxis from fetal products. 3. Status epilepticus is explicable only on the grounds of an acute autotoxic process. It closely resembles the epilepsy of uremia and eclampsia and that following the use of convulsant poisons. In some cases the author has stopped the convulsions, and yet death has occurred in a few days. All these cases show fatty degeneration of the heart. A state analogous to status epilepticus, but without convulsions, is when the patient becomes dull, ceases to take food and lapses into coma with terminal pyrexia which ends fatally. If the first form is comparable to uremic convulsions, the second is analogous to uremic coma. 4. The habitually epileptic person shows immunity from many of the common diseases, just as do those with infantilism, idiocy or cerebral diplegia, "in all of which diseases we have grounds for believing that a perversion of bodily metabolism is the essential cause." The prodromal symptoms of the epileptic seizure—exaltation, excitement, restlessness, or headache, lethargy and malaise—are indications of some general bodily change. Epileptic occurrences, of themselves, are not responsible for mental deterioration, but they must be the result of some concomitant metabolic fault.

There is no difference whatever between the clinical manifestations of epilepsy resulting from organic disease of the nervous system and those of idiopathic epilepsy. The peculiarities hitherto claimed as characteristic of the former, such as local commencement of hallucination or convulsion and slow spread or restriction of the disturbance to one region with retention of consciousness are all common features of the idiopathic disease. There is no lesion of the brain that will certainly produce epilepsy, no matter what its nature or position may be; on the other hand, there is hardly a lesion of the brain of any nature which has not produced epilepsy. Obviously, therefore, the lesion alone is not responsible. Various theories of a second factor have been offered, and the author submits that it is the same disorder of metabolism as is the fundamental cause of idiopathic epilepsy, but existing in a minor degree, so that there are no spontaneous outbursts until the local lesion of the brain is added. This idea is supported by

the work of Dandy and Elman, who found that animals with experimental lesions of the brain were more susceptible to convulsant poisons. Symptomatic epilepsy, on occasion, presents most, if not all, of the clinical phenomena of idiopathic epilepsy, and there is not one example of such convulsion which has not in some recorded case continued into an established epilepsy.

There are several diseases that have a close affinity with epilepsy, and the treatment is that which is applicable to epilepsy. The author submits that a metabolic dyscrasia is the causative factor. These conditions are migraine, pyknolepsy, narcolepsy, vasovagal attacks, syncopal attacks and tetany. Three of these, migraine, narcolepsy and tetany, sometimes occur from local lesions of the brain, and migraine is also met with in renal disease.

Migraine may be considered as a protracted form of epilepsy, having its seat of origin most often, but not always, in the posterior region of the brain and having the special association of swelling of the brain, which gives rise to the conspicuous headache and vomiting. Migraine is usually regarded as metabolic, and its close similarity to epilepsy suggests that the latter has a similar origin. Though not commonly, migraine at times occurs in epileptic patients, and the two types of attacks may alternate. Migraine may disappear with the onset of epilepsy and vice versa. There are two types of migrainous symptoms: (1) hallucinations, paralyses and abnormal mental states, and (2) headache and vomiting. The first type presents exactly the same symptoms as some epileptic patients except that they are more slow in onset and tardy in disappearance. The two types never appear at the same time but may alternate in the same persons. The symptoms of the second group, which may also have their counterpart in epilepsy, seem to be the result of actual swelling of the brain due perhaps to a local anaphylactic reaction. This swelling also accounts for the paralysis of the sixth nerve which may occur, and for death which sometimes supervenes.

The subject of narcolepsy, though usually normal in other respects, may present mental deficiency or bodily peculiarities suggestive of endocrine deficiency. There are two types of narcolepsy. One is the sudden onset of apparently normal sleep. Some patients have warning before the attack and headache afterward. The patient when aroused is wide awake at once and knows that he has slept. The second variety is termed cataleptic and seems to be produced mostly from a sudden emotion, which is usually pleasurable. There is a sudden feeling of intense weakness in the limbs, which become flaccid. The patient crumbles to the ground but often only to a sitting position. The eyelids droop, the head falls forward and the jaw drops. There is inability to move, and usually to speak, but consciousness is retained. Grimacing, protrusion of the tongue and curious movements of the head or limbs may be seen. One patient described them as repeated efforts to overcome an increasing weakness. Both types of attacks last from a few seconds to a few minutes. Blends of these two types occur, so they are not distinct. Adie considers that this is a functional disorder, primarily of endocrine origin.

Pyknolepsy is a condition characterized by an abrupt onset in childhood of attacks indistinguishable from minor attacks of epilepsy, which become very frequent, persist for years but leave no ill health or impairment of mental or physical development. The attacks are uninfluenced by treatment but come to a spontaneous end some time after puberty. The attack lasts from five to ten seconds; the power of speech and of voluntary movement is in abeyance, but the automatic movements are retained. The patient stands with the limbs relaxed, staring vacantly, but he does not fall or drop what he is holding. The lids may flicker, and the eyeballs roll up, but there are no convulsive movements and consciousness is never completely lost. The author has seen patients with more truly epileptic features and does not believe that the two conditions can be clearly separated. He believes that variation in the nature of the metabolic disturbance, which underlies epilepsy, is responsible for the type and constancy of the phenomena.

Vasovagal attacks were called vagal because of the common occurrence of epigastric sensations of discomfort, of cardiac discomfort and of respiratory

restriction sometimes associated with an impression of impending death. They were called vasal because of the pallor of the surface and the coldness of the extremities. Gowers associated this condition with epilepsy and migraine. The author holds that the pallor is due to a drop in blood pressure, and that the same explanation holds for the initial pallor of epilepsy and that of migraine and syncopal attacks. The attacks may last several hours, and in this article Collier describes a patient who had convulsions during these periods.

A syncopal attack is not an epileptic attack, but is a phenomenon of the same order and dependent on a similar pathologic process. A personal metabolic peculiarity, in subjects liable to syncopal attacks, may bring about a fall in blood pressure which leads to the attack. As in the other conditions described, this lowering of blood pressure is an essential feature. Convulsion in syncopal attacks is much more common than is supposed. It has been said that whenever the blood pressure drops suddenly to below a certain point there must be convulsions. The author has frequently observed syncopal attacks associated with convulsion, following alcohol puncture for the relief of neuralgia, facial spasm and painful periosteal points. These attacks consisted of deviation of the eyes, a gurgling sound in the throat and clonic facial spasm, sometimes spreading to the arms or even becoming general. Recovery was rapid and complete.

Tetany is proved to be the result of metabolic disturbance and may be associated with loss of consciousness and with generalized convulsions of an epileptic order. In rare instances it may appear as a result of a local lesion of the brain. Gowers reported the occurrence of tetany in association with vasovagal attacks.

Though commonly met with in epilepsy, mental deficiency and progressive mental failure are not necessarily associates of this disease. The degree of mental impairment bears no relation to the number or severity of the attacks, and such deterioration may precede the onset of fits. On the other hand, highest mental attainments may be exhibited. In a day when dementia praecox is held by some to be a disorder of endocrine or metabolic function, it is reasonable to state that a metabolic disorder is responsible for the deterioration in epilepsy, as well as for the attacks themselves. Postepileptic paralysis may occur with any form of epilepsy, but is more evident with local attacks. Simple paralysis is one of the essential manifestations of epilepsy and may be the sole manifestation, just as the paralysis of migraine is the sole manifestation of the migrainous attack in which it occurs. The disturbance of the cortex in epilepsy may secondarily give rise to phenomena which belong to lower regions of the nervous system, such as pain of thalamic origin. The author believes that "subcortical epilepsy" results from a cortical disturbance, but that the manifestations belong to the presumable function of subcortical levels.

A drop in blood pressure occurs in the aforementioned epilepsy-like maladies and is a common manifestation of the commencement of an epileptic attack. Collier believes that this fall in blood pressure, and not a vasoconstriction, causes the blanching of the brain which has been reported by observers. The site of origin of epilepsy seems definitely confined to the cortex of the cerebral hemispheres according to the author. He does not agree with the classification of Spiller and others of "sub-cortical epilepsy." The belief that the site of origin of a tonic attack is near the basal ganglia does not appeal to him as strongly as the theory that the cortical disturbance may give rise to a secondary disturbance of the lower centers, with symptoms corresponding with one's ideas of what disturbance of the lower centers would cause. It is true that tonic-clonic spasms can be elicited by the administration of convulsant poisons to decerebrate and "spinal" animals, and so the origin of epileptic-like fits in the spinal cord and brain stem is theoretically possible. But if such events occur as spontaneous clinical phenomena in man, they must be extremely rare. The opinion is widely held nowadays that the essential element in the epileptic attack is a sudden loss of function, local or general, in the higher levels of the nervous system, and that all positive phenomena which occur, such as hallucinations and convulsions, are of the nature of "release" phenomena in lower centers. If this is true, some of the release phenomena must

be of a negative order, such, for example, as the complete loss of sensibility to all forms of stimulation following on sensory attacks, which must involve complete loss of function at a level not higher than the thalamus. Postepileptic phenomena must depend on some factor, sometimes present and sometimes absent, and not on the attack itself. Postepileptic headache and some of its characteristics, for example, sudden cessation after vomiting, remind one of migraine and suggests that swelling of the brain sometimes occurs in epilepsy, as it certainly does in migraine.

The less the life of an epileptic patient departs from that of a normal person the greater will be the result of medicinal treatment and the more hopeful will be the outlook. States of bodily peculiarity and ill health have often been held responsible for the attacks, but, with the exception of rickets, the author has noticed no improvement following their cessation. Some of them he regards as evidence of the metabolic disturbance which is the cause of the epilepsy. Phenobarbital is of greater value than bromides in treatment, though a few cases respond to the latter and not to the former. When both of these have failed, zinc salts or belladonna may be efficacious. These drugs fail in status epilepticus, in which depressants do more harm than good. Fluids, food, stimulants and paraldehyde, up to 8 drachms (29.75 cc.), by rectum, are of most value.

PETERSEN, Montreal.

THE FUNCTIONAL PROBLEM OF THE BLOOD-SPINAL FLUID BARRIER. V. KAFKA, Deutsche Ztschr. f. Nervenh. **105**:50 (Sept.) 1928.

Recent studies of the blood-spinal fluid barrier have brought to light important facts with regard to physiology and pathologic physiology, and its relation to the central nervous system, such as the alimentation of the central organs, the origin of the different mental and neurologic diseases and formation of antibodies in the spinal fluid.

The question of the anatomic substratum of the blood-spinal fluid barrier has been variously answered. The reason for the differences might be because some authors identified the site of the formation of spinal fluid with the site of permeability, or because no sufficient differentiation was kept in mind between the normal and the pathologic. The plexus is to be considered as the main seat for the formation of spinal fluid normally. There is no observation that contradicts it. The slight differences observed in the normal comparison of the fluid in the ventricles and around the cord can be easily explained. The plexus as such is also the site of normal and natural permeability. It is different with abnormal permeability. By it Kafka has in mind those types in which a disease process has not yet fully developed and is only the result of an abnormal accumulation of products in the blood or near the liquor spaces. In such conditions, the subarachnoid space with its blood vessels becomes active, in addition to the plexus. In pathologic conditions the plexus plays a minor rôle and the subarachnoid space becomes the leading factor, especially in inflammatory processes of the meninges. Kafka cannot accept Walters' reasoning that since the entire blood-cerebrospinal fluid barrier possesses the capacity of permeability the formation of fluid also occurs along the entire line, nor does he agree with Hauptmann that the spinal fluid also contains a constituent part of serum from the lymph spaces of the cerebral blood vessels. Examinations of normal spinal fluid do not substantiate this assumption.

The blood-cerebrospinal fluid barrier cannot be considered as a semipermeable membrane as some investigators are inclined to do. It is a complicated structure possessing different types of cells, and containing a considerable number of sympathetic nerve fibers; it is embedded within continuously changing vital processes that cannot imitate laboratory reagents. In investigations of permeability, a distinction should be made between natural and artificial methods. In the former one investigates substances ordinarily formed in the blood and in the liquor in different diseases. In the artificial method, a substance is introduced into the body and then looked for in the blood and spinal fluid. It is not always safe to draw conclusions from observations in lower animals and to apply them to man. The

cerebrospinal fluid permeability conditions in lower animals differ from those in man. Experimental results on lower animals can be applied to human pathology only when they are found to be identical.

As regards natural methods of investigation, Wichmann and Dominick's investigations of sugar and amino nitrogen in the blood plasma and in the spinal fluid lead to nothing definite; they failed to establish what constituents are formed locally; there is also the possibility that the spinal fluid has the power to break down sugar under special conditions. The hemolysin reaction is concerned with the establishment in the spinal fluid of normal hemolytic amboceptors and also of complement since these constituents are not found normally. Weil and Kafka considered this reaction as a permeability test, and have established that the strength of the reaction depends on the kind and degree of permeability as well as on the blood titer. Walter disputed this and pointed to cases in which it was negative in the blood and positive in the fluid. Kafka, however, has shown that normal amboceptor is often thermolabile and that therefore its presence cannot be determined in a fluid that has been heated to 56 C. With newer methods the author was able to establish the presence of normal amboceptors in the blood and in some cases in the fluid, which was not possible with older methods.

A great deal more work has been done with the so-called artificial method. One of the newer methods of investigation is that of Flatau, the chromoneuroscopic S-fuchsin test. A 5 per cent solution of S-fuchsin is injected intramuscularly. After from one and one-half to two hours, a lumbar puncture is done; 5 or 6 drops of the spinal fluid is put drop by drop into a solution composed of hydrochloric acid and 95 per cent alcohol in the proportion of 1:9. A violet color is indicative of a positive reaction; the number of plus marks is assigned in accordance with the intensity of the color. It is interesting to observe that Flatau found this reaction positively only in acute meningitis. He found it positive also in only one case of spinal tumor, one case of tuberculous spondylitis, one case of hydrocephalus, and one case of thrombosis of the posterior inferior cerebellar artery. All cases of paralysis gave a negative result. This method, therefore, at present has only a value in the diagnosis of meningitis. Loberg, using sodium salicylate in definite doses in thirty-two cases, concluded that the permeability generally rises with the height of the blood titer, but that there are also a number of exceptions which he is unable to explain. In dementia praecox he obtained quotients from 4.9 to 15.5; hence there was nothing characteristic for this disease.

Of special significance is the work by Singer and Münzer. They immunized patients with blood cells from sheep and studied the hemolysin content of the spinal fluid at the height of the blood titer. They invariably found it to be independent of the kind of disease and of the spinal fluid observations, especially when the serum titer was from 0.0001 to 0.0005. They also produced a passive immunity with agglutinated typhoid serum and were able to demonstrate the presence of immune bodies in the spinal fluid. These investigations indicate that a substance may pass over into the cerebrospinal fluid, when the blood titer is sufficently raised, without affecting the permeability for other substances. Animal experiments by Wohlgemuth and Szesci, as well as by Kafka, gave similar results. As for Walter's bromide method, in which bromides are given daily and the blood serum is examined, Kafka suggests examination of the spinal fluid at the same time for bromides, for there is a difference in the length of time during which different substances remain in the blood and spinal fluid; a change in the permeability quotient may be due to this factor and not be the result of an altered permeability. This factor becomes important in diminished permeability; hence the observations obtained with the bromide method should not be generalized into far-reaching deductions. Diminished permeability is found in cases in which the permeablity quotient is higher than normal, and the bromide passes over into the cerebrospinal fluid in a lesser quantity than normal.

Hauptmann, finding these results in schizophrenia, argued that since bromides pass into the cerebrospinal fluid in a less degree, other substances either fail to enter entirely or enter the fluid, and hence the central nervous system, in a lesser

quantity; hence he considered that this is the pathogenesis of this disease. Later investigations have partly substantiated Hauptmann's observations; again, cases of schizophrenia have been found to be within normal limits. Kafka, investigating cases of schizophrenia, found that the sugar and chlorides were normal, while the globulin and albumins were generally increased. Guttmann, in schizophrenia, found a delay in the absorption of iodine injected by the endolumbar route. Kafka suggests the need in schizophrenia of greater study of the concentration of the spinal fluid after the colloids have been removed, and of a more refined method of examination. The albumin may come from the central nervous system. It is certain that, so far, the analyses do not prove a diminished normal permeability. The increase in the permeability quotient for bromides may be explained on other bases. The time period for bromides to remain in the blood and the cerebrospinal fluid may have changed, and delayed resorption may have taken place. Kafka records these observations without drawing any definite generalized conclusions on the pathogenesis of schizophrenia.

Hauptmann, stimulated by Walter's observations, extended this method of study of the spinal fluid to the investigation of other psychoses and drew conclusions with reference to their pathogenesis. Hauptmann's assumption finds support in the work of Monakow, Stern and Gautier, who assume that the cerebrospinal fluid is secreted by the plexus, that it enters the brain substance by passing through the cerebrospinal fluid clefts, nourishing the brain cells and carrying off broken down products into the subarachnoid space where it is absorbed. These authors assume that nothing can enter the brain substance without first being in the cerebral fluid, so that, to a certain extent, the liquor system stands interpolated between the brain and the blood to act as a nourishing source for the central nervous system. Sepp accepts this theory. Lange, on the other hand, does not agree with it. Kafka is of the opinion that the subject needs greater clarification. If the liquor is really the nourishing fluid of the central nervous system, greater attention must be paid in its examination on days when the patient feels better and on days when he feels worse, which may lead to a better knowledge of the mechanism of formation of the cerebrospinal fluid. The assumption that the liquor is the nourishing fluid brings with it also the idea that it comes in innermost contact with the central nervous system. The liquor, therefore, should reflect anatomic changes of the central organs. Regarding this nothing essential has been brought to light.

The same can be said regarding the problem of the production of antibodies in the cerebrospinal fluid, which is likewise connected with the function of the blood-liquor barrier. Whether the Wassermann reaction is the result of an antibody reaction has not definitely been settled. Lately, Sachs and his school incline to answer the question in the affirmative. A definite answer to this question would at the same time settle the problem of a local production of antibodies in the liquor space. Kafka agrees with Italian investigators that the genesis of the Wassermann reaction is mainly local, but not necessarily so. It appears that the thermostabile reagent is of local origin and the thermolabile one comes from the blood. If it is assumed that the Wassermann reaction is always an antibody reaction, then there must be assigned to the liquor space the ability to produce antibodies. However, Neufeld and Neufeld and Szyli were unable to show experimentally the formation of antibodies. Plaut, in his latest work, definitely assumed a local antibody development from invasion of the nervous system with *Spirochaeta recurrens*. Illert believes that he has found the same as a result of injections of endolumbar antigen. From the frequency and strength of the Wassermann reaction in the fluid it could also be argued that the reagents may be not always antibodies, but chemical substances which have their origin in the central nervous system. Experiments carried on by Kafka and Gozzano lead to this possibility. The Wassermann reaction was removed from the liquor by shaking it with ether, and could again be found in the floating ether extract in sodium chloride solution. So far there is no exact chemical investigation to substantiate this principle. None the less, it indicates that this problem is not yet settled. Until such time, all work on permeability is necessarily one-sided.

BERNIS, Rochester, N. Y.

POLIOENCEPHALITIS HEMORRHAGICA SUPERIOR (WERNICKE). FRITZ LÜTHY and KARL M. WALTHARD, Ztschr. f. d. ges. Neurol. u. Psychiat. **116**:404 (Oct.) 1928.

Lüthy and Walthard believe there are still many problems to be settled with regard to Wernicke's polioencephalitis hemorrhagica superior. They report the case of a man, aged 27, who was a heavy drinker, who entered the hospital with mental symptoms consisting of confusion and disorientation. He showed a complete external ophthalmoplegia and an almost complete internal ophthalmoplegia, a slight pupillary reaction remaining in the left eye. Necropsy revealed a polioencephalitis hemorrhagica superior, bronchopneumonia and early cirrhosis of the liver with brown atrophy. Section of the brain through the colliculi showed the entire central gray matter in the region of the oculomotor nucleus red, soft and sprinkled with extremely fine hemorrhages. These changes were present in a limited area around the aqueduct of Sylvius. Similar changes of like intensity were present in sections through the posterior part of the third ventricle. The brain substance immediately surrounding the ventricle was red and soft for a distance of about 3 to 5 mm. Here and there extremely small hemorrhages were demonstrable. At the cranial end of the third ventricle only a few hemorrhages were visible. The hemorrhages decreased markedly at the fourth ventricle, and the abducens and facial nuclei showed no changes. Microscopically, the following changes were noted in these areas: 1. In the sections through the colliculi there was marked new capillary formation, swelling of some of the endothelial cells in the vessels, occasional perivascular infiltration by round cells, round cells in the tissues, regressive changes in the ganglion and neuroglia cells and numerous hemorrhages, chiefly perivascular. The large cells of the oculomotor nucleus were relatively unchanged. 2. Around the third ventricle, the changes were the same as those already described except that they were much more intense. The tissues and blood vessels were filled with and surrounded by numerous lymphocytes. The endothelial cells of the vessels were markedly swollen, and the adventitia itself was infiltrated with small cells. The corpora mammillaria were particularly affected by these changes. The pathologic changes were limited to the brain tissue immediately below the ependyma of the third ventricle for a depth of about 3 mm.

The pathologic condition in this case differs somewhat from that described by Wernicke: a reddish staining of the tissues around the third ventricle for a distance of from 3 to 5 mm. with numerous pinpoint hemorrhages. These changes are bilateral and almost mathematically the same on both sides; often they are seen in the middle commissure. Microscopically, hemorrhages are seen in the vessels without changes in the vessel walls. Wernicke reported three cases: one in a man, aged 20, who was poisoned by sulphur, and the others in men, aged 33 and 36, who were alcoholic.

The first question with regard to polioencephalitis hemorrhagica superior is whether it is an inflammatory process or the result of toxic injuries to the vessels. Wernicke regarded it as apparently of inflammatory origin. The concept that it was such was influenced by a case reported by Goldflam of a polioencephalitis superior, inferior and anterior, following influenza, and another similar case due to syphilis reported by Hori and Schlesinger. The pathologic processes in their cases, however, spread far beyond that originally described by Wernicke. Spielmeyer disclaimed that the process described by Wernicke is an encephalitis and denied its inflammatory nature. He said that the process was not a true inflammation; that the hemorrhages were caused by a diathesis hemorrhagica, and that the new vessel formation occurred because the pathologic process happened to be in a markedly vascular area. He warned that the purely hemorrhagic cases were often accompanied by inflammatory processes, apparently caused by the hemorrhages. Gacuper (1927) confirmed Spielmeyer's statements, and denied that polioencephalitis superior of Wernicke was an inflammatory process.

Lüthy and Walthard believe that in their case there occurred the following sequence: Chronic alcoholism led to an injury of the subependymal vascular endothelium; this led to a proliferation of vessels. The area in which this occurred

(third ventricle and aqueduct) thus became a locus minoris resistentiae, and since it is known that the resistance in alcoholic is lower than in nonalcoholic persons, a secondary infection set in and became localized in the area of decreased resistance. This explains to them the occurrence of inflammatory and noninflammatory processes. The fact that in many cases no evidences of inflammation are present is explained by the suggestion that death may intervene before an inflammation has time to develop. The time factor, in the conception of Lüthy and Walthard, is important. The duration of the illness in the case reported was four weeks, whereas in Spielmeyer's case it was only twelve days. The different microscopic observations present in one and the same clinical picture of Wernicke's polioencephalitis superior can be explained on the basis of two independent factors: a time factor and a qualitative factor. The first, often fatal in itself, is the polioencephalitis hemorrhagica superior of Wernicke in the narrower sense of the word. It is not an inflammatory process but is characterized by proliferative changes: a tendency to the formation of new vessels with and without hemorrhages. The second factor, coming into play after the first, is the polioencephalitis hemorrhagica superior in the wider sense of the word. This is a true inflammation, and is characterized by all the evidences of an inflammatory process. Another factor which prompts Lüthy and Walthard to divide the syndrome into these two factors, and to confine the concept of polioencephalitis superior of Wernicke to the narrow noninflammatory concept, is the etiology of the disease. In Wernicke's three original cases, there were no evidences of inflammation in any other organs in the body. The causative factors in his cases were poisoning due to sulphur and alcohol. In the case of Lüthy and Walthard alcohol also was the etiologic factor. Spielmeyer has suggested, and the authors agree, that alcohol has a direct influence on the tendency to the formation of new vessels. The alcohol in the blood stream and cerebrospinal fluid is diffused through the ventricular ependyma into the brain substance, and there can provoke degenerative processes in the vessels and their surroundings.

ALPERS, Philadelphia.

THE SO-CALLED HOUR-GLASS TUMORS OF THE SPINE. GEORGE J. HEUER, Arch. Surg. **18**:935 (April) 1929.

The term "hour-glass tumors" is applied to a group of tumors which arise along the spine from the highest cervical to the lower sacral vertebrae, either from within the spinal canal (ganglions, nerves, dura, vertebral ligaments), from the vertebrae (cartilage of intervertebral disks) or from without the spine (sympathetic chain, ribs, fascia). Arising intraspinally, they have been thought to grow outward through an intervertebral foramen or between two adjoining laminae to form an extravertebral or paravertebral tumor; arising paravertebrally, they have been thought to extend through an intervertebral foramen into the spinal canal to form there an intraspinal growth. At the point where they penetrate the intervertebral foramina the tumors are constricted and assume, therefore, an hour-glass shape. The term has been used to include tumors which are entirely intraspinal but which are both intradural and extradural. Arising either within or without the dura, they penetrate this membrane usually at the site of exit of a spinal nerve, at which point they are constricted and assume an hour-glass shape. It is to be noted that the intervertebral foramina occupied by tumor tissue are usually enlarged as if by pressure atrophy of the bone rather than by invasion of the bone. The term hour-glass tumors has not been applied to the not uncommon malignant tumors (sarcoma, metastatic carcinoma, etc.) which invade and destroy the vertebrae and involve the spinal cord.

It appears that the hour-glass tumors of the spine arise from the membranes, the ganglions and the nerve roots of the spinal cord, from the ligaments and fasciae in or about the vertebrae, from the cartilage of the articular surfaces of the vertebrae and ribs, from the intraspinal epidural fat and from the sympathetic nervous system. The great majority of these tumors have been benign, encapsulated growths; a few have been definitely malignant.

For the purpose of further discussion these tumors may be conveniently grouped according to the region in which they occurred into cervical, dorsal and lumbosacral tumors. Of the sixty-four cases, eighteen occurred in the cervical, thirty-seven in the dorsal and eight in the lumbosacral region. In one case the condition was general, and multiple tumors occurred throughout the length of the cord.

There is little to be said about the symptomatology and the clinical signs of the hour-glass tumors. The outspoken symptoms, with only two exceptions, have been those due to compression of the spinal cord and have differed in no way from those of other tumors of the spinal cord. They need not again be detailed. They have either almost completely overshadowed other symptoms or other symptoms have been strikingly absent.

Recognition of the true nature of the hour-glass tumors has been rare. The symptoms of cord compression have, of course, been recognized and the diagnosis of tumor of the cord has almost invariably been made; but in the past, at least, the association between the tumor of the cord and a tumor of the neck, the back or the mediastinum has only been recognized at the operating or the autopsy table. The most important matter in the diagnosis of the hour-glass tumors is the recognition of the fact that these tumors occur. Granted this, the presence of symptoms of tumor of the cord combined with the presence of a paravertebral tumor at a level corresponding with that of the tumor of the cord strongly suggests an hour-glass tumor. The routine examination of patients with possible tumors of the cord should include not only a careful neurologic examination but also, depending on the level of the spinal lesion, a careful examination including a roentgenogram of the neck, the thorax, the back, the abdomen and the pelvis. Otherwise, a paravertebral tumor may well be missed.

With regard to the treatment for these lesions, when hour-glass tumors of the cervical region associated with paravertebral tumors are encountered, the primary approach should be directed to the removal of the tumor of the cord, but chiefly because of the urgency of the cord symptoms. The feasibility of removing a paravertebral tumor of the neck or mediastinum through the laminectomy incision and at the same sitting will depend on the location of the paravertebral tumor. If its location is such as not to lend itself easily to removal through the laminectomy incision, it is perhaps better to remove it through another incision either at the same time or at a subsequent sitting.

In the hour-glass tumors of the dorsal region associated with paravertebral tumors, the primary approach again should be directed to the removal of the tumor of the cord, not only because of the urgency of the cord symptoms but because of the possibility of removing, through the primary incision and at the same time, the paravertebral tumor. In twenty of the twenty-nine patients subjected to operation, the operation was completed at one sitting, in seventeen of which a tumor of the mediastinum or of the back was removed with the tumor of the cord. From a survey of the reported cases there seems no good reason for attacking the mediastinal tumor primarily. In only two cases in which at the time there were no cord symptoms did the procedure appear rational.

What has been said of the hour-glass tumors of the dorsal region applies equally to those of the lumbosacral region. A primary laminectomy may permit the removal, through the same incision and at the same time, of a tumor of the back or the pelvis. An exception may well be the occasional retroperitoneal tumor, which if discovered may have to be approached through an abdominal incision.

GRANT, Philadelphia.

HYSTERICAL CHANGES IN THE VISUAL FIELDS AND THE HYSTERICAL MECHANISM. E. RAKONITZ, Arch. f. Psychiat. **84**:392 (Aug.) 1928.

The author discusses the possibility that organic mechanisms are the basis of the hysterical syndrome in general and of the changes in the visual fields in particular. The characteristics of these latter changes are considered, and the author sums them up as follows: They are mostly bilateral; there is a concentric

constriction for both white and colors; there is a crossing, contiguity and overlapping of the blue and red fields, as well as an inverted color series (the blue color field suffers a relatively most marked constriction, thus bringing about a preponderance of the red field); there is a larger field for both white and color when the object is brought from the periphery inward than when it is moved from the center outward. Added to these fairly consistent characteristics, there are others which may be found in hysterical changes of the field of vision: The shape of the visual field may be circular or elliptoid; the boundaries of the color fields may be irregular and make inroads into one another; telescopic vision is sometimes seen. In some rare cases there may be an exaggeration of the field of vision exceeding the physiologic limits for white or for colors either of the whole field or of parts of it. Occasionally, too, one may find an intact field for white with a pronounced disturbance in one or more color fields.

Numerous theories have been advanced to explain the mechanism of these changes, the most probable causes, as considered by different authors, being as follows: (1) the lack or disturbance of attention; (2) the psychic influences, such as the belief of being unable to see (brought about by heterosuggestion, autosuggestion or simulation); (3) a constriction of consciousness; (4) unconscious components; (5) an organic disturbance in the irritability of the visual projection.

Different observers have found proofs for any one or more of these causes, as well as arguments against others. The author is of the opinion that although some of the causes mentioned may help in determining the exact nature and form of the change in the visual field, the most important condition is that of an organic change in the physiology of the visual apparatus, and that this is probably brought about by changes in the blood chemistry. One of the most important arguments, according to the author, that would speak for the change being of an organic nature is the fact that more or less similar disturbances of the field of vision are found in a great many toxic and infectious diseases. He mentions, as an example, disturbances due to alcoholic intoxication, those found in multiple sclerosis, in quinine intoxication, in salicylic acid poisoning, in tobacco amblyopia, in arsenic poisoning, in diabetes mellitus and in uremia, and numerous others. Another argument that would speak against active simulation is the fact that the changes brought about are fairly constant in most patients suffering with hysteria, and occur in persons who could not possibly know what the limits of these constrictions should be. Furthermore, experiments undertaken on people who are told to simulate constrictions of visual fields, or conditions of poor vision, bring out changes of an altogether different type, and vary with the different individuals. This and other arguments of this type would lead him to believe that these changes must be due to an organic cause, and since in the intoxications and infectious diseases mentioned the changes are most probably due to disturbances of blood chemistry, one can assume that here too such changes take place. Of the three possible levels, the cortex, corpus geniculatum and retina, it would seem that the change is due most probably to a disturbance in the geniculate body. From this assumption the author says further that the whole hysterical syndrome depends on some organic causes, that is, changes in blood chemistry.

To the reviewer, it seems that the author's arguments and assumptions have at least as little foundation in actual facts as any one of the other theories. These assumptions, furthermore, have the drawback of not yet being substantiated by investigations on blood chemistry, which one would suppose should really precede theories of this type.

MALAMUD, Foxborough, Mass.

ON THE PATH OF THE SECRETION OF THE HORMONES. Q. C. CHUJI MUTO, Acta med. in Keijo, vol. 11.

Some have contended that the pancreatic hormone passes into the lymphatic system, while others have insisted that it passes at once into the blood. The author, while using the pancreas of the guinea-pig as antigen in peritoneal injections into the rabbit, and developing a specific reaction in the rabbit system, found that

this serum was also specific with an aqueous extract of the pancreas of the fowl. He found that the pancreatic substance was secreted in both lymph and blood, but the amount found in the blood was greater than that in the lymph. Injections of the lymph and blood serum from the pancreas of a rabbit produced a lowering of the blood sugar in both instances, but he declared that the substance thus lowering the blood sugar was greater in amount in the lymph than in the serum of the blood.

Similar precipitin tests with the extract of testes from a mouse gave evidence that the testicular substance was secreted chiefly into the blood and less into the lymph. By measurement of prostatic atrophy after castration, the author endeavored to determine whether the blood from the vena spermatica contained the testicular hormone or not. Blood serum from the jugular vein of a goat could not prevent the atrophy of the prostate after castration, while that from the vena spermatica did have this effect. Testicular lymph also prevented this atrophy, and the author concludes that the testicular hormone is secreted in almost the same amount into the blood as into the lymph.

In tracing the path of secretion from the pituitary body, the following three roots were considered possible: (1) the anterior facial vein; (2) the posterior facial vein; (3) the cerebrospinal fluid.

To determine the presence of the hormone of the anterior lobe, blood serum and cerebrospinal fluid were injected subcutaneously into infant mice, and the growth of the genital tracts was observed. Zondek and Aschheim reported that a hormone from the anterior lobe of the pituitary distends the genital tracts of infant mice, leading to early maturity in from 90 to 100 hours after the implantation of its tissue. Results of this kind were observed by the author after the injection of an anterior pituitary preparation. He found that the uterus became larger, as well as the oviducts, as contrasted with control mice.

Injection of 0.2 cc. of cerebrospinal fluid, diluted 10 per cent, obtained from the lateral ventricle of the rabbit, produced no such change, but the injection of venous blood serum, in a similar dilution, obtained from the anterior facial vein, produced marked growth in ovaries and uterus as compared with the controls. They were as much enlarged as those following the injection of an anterior pituitary preparation.

Blood serum derived from the posterior facial vein did not give these results; hence the author concludes that the hormone from the anterior lobe of the pituitary is secreted only into the venous blood and carried only by the anterior facial vein.

The pigmentation of the skin and changes in the melanophore cells in the cutis of the frog, following the use of the hormone from the posterior lobe of the pituitary, was used for the detection of that hormone, and since it was found that injection of a 10 per cent dilution of cerebrospinal fluid produced these pigmentary changes, as well as injection of diluted serum from the posterior facial vein, it was concluded that the hormone was secreted into the cerebrospinal fluid as well as into that vein. This hormone was not found in the blood from the anterior facial vein.

HART, Greenwich, Conn.

SINUS PERICRANII (REDUCIBLE BLOOD TUMOR OF THE CRANIUM). E. VERNON HAHN, Arch. Surg. **16**:31 (Jan.) 1928.

Clinically, sinus pericranii presents a soft, compressible, fluctuant swelling which increases in size when the patient assumes a posture with the head down, when he flexes his neck sharply or when he raises his intrathoracic pressure by coughing, crying or making an expiratory effort with the glottis closed. Digital compression of the jugular veins also causes the swelling to grow larger. Indeed, the lesion may not be apparent unless some of the factors that increase intracranial venous pressure are active. A bluish color is sometimes visible through the skin over the swelling, but when it is not, the tumor is easily mistaken by the unwary for a meningocele. The roentgenogram of the skull generally shows an area of rarefaction or a perforation corresponding to the situation of the tumor.

Few, if any, symptoms accompany the anomaly. Pain of moderate severity and vague cerebral disturbances have been recorded in some of the reported cases.

The age incidence is from birth to late maturity. Many of the cases in older subjects are significantly related to antecedent trauma. In most of the cases the lesion has been progressive, frequently starting as a small nodule and gradually developing into a tumor several centimeters in diameter.

In the case reported the growth was surgically extirpated. As might be expected in handling a tumor of the blood vessels control of hemorrhage was one of the chief problems. This was easily accomplished by electrocoagulation. The tumor was found to communicate with the bone by about ten small veins. The bone under the tumor presented an oval depression corresponding exactly to the size of the tumor. The floor of the depression was flat and apparently on a level with the inner table, as the depth of the depression was about the estimated thickness of the outer table and diploe. The margin of the depression was smooth. The outer table of the surrounding normal bone merely shelved down abruptly to become continuous with the floor which was sievelike by virtue of about ten foramens, each of which was occupied by the stump of a delicate vein. Wound healing resulted by first intention. The patient reported ten months later that there had not been a recurrence of the tumor or of the symptoms which were associated with it.

Microscopically, the tumor showed a layer of dense avascular connective tissue surrounding a delicate connective framework in which lay many irregular communicating sinuses lined with endothelium. Sections stained to show elastic tissue revealed numerous elastic fibers in and about the walls of the sinuses. The incidence of so much elastic tissue and its relation to the blood spaces are evidence in favor of the view that the entire lesion arose from previously existing blood vessels and not by organization and canalization of a hematoma.

GRANT, Philadelphia.

STUDIES IN PERIMETRY: II. PRELIMINARY WORK ON A DIAGNOSTIC SCALE FOR THE COLOR FIELDS. C. E. FERREE, G. RAND and M. M. MONROE, Am. J. Ophth. **12**:269 (April) 1929.

Ferree and Rand, in their study of perimetry, show that factors enter into the variation of fields under normal conditions which are not pathologic. They may be variations from individual to individual. These variations depend on the wave length, the purity, intensity and size of the stimulus, angles subtended at the eye, length and methods of exposure, breadth of the pupil, and brightness of the pre-exposure and of background or surrounding field; also the methods of approach and the methods of judging the limits for colors, which change hue in passing through the periphery of the field. They attempt to formulate a scale showing a typical distribution of results in nonpathologic cases. They have classified nonpathologic myopes, hyperopes, presbyopes and mixed astigmatisms, and show that there are many variations.

As they point out, it is important in the determination of the color fields to have a constant illumination of the stimulus, and no difference in brightness between the surface which serves as pre-exposure and the surrounding field. The latter eliminates all variable effects due to brightness, after images, and all brightness induced by the surrounding field on the power of the retina to respond to color. It also renders the judgment of the limit more certain and easy to make, since at the limit of sensitivity the stimulus become distinguishable from the background when the background has the same brightness as the color.

The results show that emmetropes and hyperopes have a wider field. The myopes and presbyopes have narrower fields. They also show that the range of variation for color fields is much larger than that for form fields. The tests made show that the widest range is manifested in the myopic group, and the narrowest in the emmetropic group.

In the laboratory studies, the average breadth of form field was observed to be about 67.5 degrees; the average in the clinical determinations showed the field to be about 66.4 degrees. In the laboratory studies for color fields, the average

breadth of the field for blue was 46.1 degrees, for red, 45.9 degrees and for green 38.4 degrees. In clinical studies the average breadth of field for blue was 42.3 degrees, for red, 36.8 degrees and for green 24.7 degrees. In the laboratory studies the form field varied from 62.3 to 72.6 degrees, a range of 15 per cent; in the clinical study, from 59.9 to 74.4 degrees, a range of 24 per cent. The variation in the form field studies between the laboratory and the clinic shows a difference of 9 per cent.

The tests made show that in the color fields the average breadth of field was considerably less for the clinical than for the laboratory group.

DE LONG, Philadelphia.

A DISCUSSION OF THE QUESTION OF POLYDIPSIA. A. H. MOLOCHOV, Collected Papers, Psychiatric Clinic of the First Moscow State University **2**:282, 1927.

The literature dealing with the subject of polydipsia is discussed by the author in an attempt to differentiate a primary psychogenic or neurogenic polydipsia from diabetes insipidus. There seems to be a clearcut group of cases in which one is not able to demonstrate any disturbance of the water metabolism and in which there is a pathologic craving for water, with marked exaggeration of the normal feeling of thirst owing to special psychogenic or neurogenic factors.

The author quotes three cases in boys, aged 4, 16 and 17, respectively. In the first case, a boy, aged 3½, developed polydipsia following whooping cough. Nine months after the onset of the symptoms, the boy was consuming twenty-five glasses of water a day. This was accompanied by a marked personality change. The child became cranky, irritable, restless and disrespectful and hit other children. Various metabolic studies gave negative results. Neurologic examination gave negative results. Once the boy passed some intestinal parasites following the administration of male fern. There was marked improvement in his condition after he left the clinic, especially in his social adaptations, although he still consumed large quantities of water. The boy was followed for a year after he was discharged from the clinic. Analysis of the case leads the author to the conclusion that one is dealing with special habit formations following whooping cough, as drinking of water helped the boy's "whoops."

The second case is that of a boy who had always been rather dull and unintelligent. Two months before the onset of the present illness, he developed a habit of spitting a great deal, associated with touching his genitalia with his right hand at the same time. The symptoms progressed so rapidly that one month after the onset of polydipsia, he drank two pails of water a day. He was studied extensively in the medical and psychiatric clinics with negative results as far as the metabolism was concernd. The x-ray pictures of the skull and sella were normal. Following treatment in the clinic with phenobarbital and restriction of fluid intake, there was marked improvement. Nine months after discharge, the patient drank only seven or eight glasses a day. In the third case, there was a definite history of epidemic encephalitis.

The author concludes his article by stating that polydipsia even in the most extreme degree is not necessarily a symptom of diabetes insipidus, and that psychogenic factors may be just as important in the etiology of this condition. Unfortunately, when polydipsia starts first as a symptom of some underlying emotional factors it sets up a vicious organic cycle and leads eventually to an increased thirst due to concentration of the blood.

KASANIN, Boston.

TUMORS IN THE REGION OF THE THIRD VENTRICLE AND THEIR DIAGNOSIS AND RELATION TO PATHOLOGICAL SLEEP. J. F. FULTON and P. BAILEY, J. Nerv. & Ment. Dis. **69**:1 (Jan.) 1929.

A series of cases of tumor, in which somnolence was a striking feature, is presented for study. Periodic somnolence, termed narcolepsy, was first described by Gelineau, and the association with weakness and emotional outbursts was

observed by Adie, but none of Gelineau's cases came to autopsy. The authors are of the opinion that somnolence without intracranial tension, unlike that with intracranial tension, is of localizing value, for cases showing this hypersomnia have shown involvement of the base and tuber cinereum.

The syndrome of the third ventricle should be separated sharply from hypophyseal syndromes, and in the cases described the lesions were for the most part infundibular, or associated with the third ventricle. Amenorrhea, polyuria, adiposity, drowsiness, nausea, vomiting, failure of vision, memory defects and headaches were characteristic symptoms. Tumors situated within the third ventricle are less definite in their localizing symptoms, and hypersomnia was less pronounced.

Tumors in the upper region of the ventricle are more apt to give rise to intracranial tension by blocking the foramen of Monro or the aqueduct of Sylvius. Pyramidal and extrapyramidal symptoms, parkinsonism, and rigidity of a decerebrate character, due to pressure on the internal capsule from the lateral walls of the ventricle, have been demonstrated.

One case, described by Davis, showed decerebrate rigidity with Magnus and DeKleijn reflexes on rotation of the head. Ataxia leading to confusion with cerebellar diseases probably arises from pressure on the red nucleus, or cerebrocerebellar association tracts. Fever and disturbances of heat regulation have been reported in which lesions were found in the basal ganglia, third ventricle or aqueduct, and animal experimentation appears to indicate a heat-regulating center in the posterior thalamic or subthalamic region. Optic atrophy, through pressure on the tracts, pupillary disturbances and paralysis of conjugate eye movements have been noted. Intellectual deterioration and loss of memory have been explained by Weisenburg as due to hydrocephalus. Emotional negativism and fatuous serenity, together with violent maniacal excitation, are states of mind described by numerous authors. Kleist has enumerated several mental symptom complexes of the brain stem; recent attacks of encephalitis in this region have given rise to speculation on the connection between the affective life of the patient and the state of his hypothalamus, which has come to be regarded by Cannon and others as the chief seat for integration of emotional reactions. The authors agree with Marchand that psychoses may be due to lesions in this region, which after a period of years show no traces at autopsy.

HART, Greenwich, Conn.

METABOLISM STUDIES IN EPILEPSY: I. INVESTIGATIONS ON CARBOHYDRATE METABOLISM. II. THE ALKALI RESERVE. J. M. VILLACIAN and J. ANDREU URRA, Med. Ibera, April, 1928, nos. 544 and 545.

A study was made of the carbohydrate metabolism in eighty-seven epileptic patients (66 males, 21 females) with convulsive manifestations. The patients were not allowed food before the tests, and were previously kept resting for fourteen hours. Blood (from 6 to 10 cc.) was obtained from a vein for the determination of the glycemic index and alkali reserve. At the same time, 50 Gm. of pure dextrose, dissolved in 150 cc. of water, was given, and determinations of the ensuing glycemia were made every half hour for a period of an hour and a half. The Folin-Wu test was used for the purpose.

From their investigations the authors conclude that hypoglycemia is the most frequent alteration, occurring in 57.5 per cent of the cases. Normal glycemia was found in 35.7 per cent, and hyperglycemia in 5.6 per cent of the patients. The proportion of cases of hypoglycemia becomes 61 per cent when only patients suffering from essential epilepsy are considered. The latter also give a higher percentage (23 per cent) of hyperglycemia, while normal glycemia is found in only 15 per cent of the cases. The hyperglycemic reaction manifested after some attacks lasts only a few moments. From a study of the glycemic curves in eighty-four epileptic patients it is concluded that the curves are high in 23.8 per cent, low in 12 per cent and normal in 64 per cent of the cases. No close relationship between the form and intensity of the mental perturbation and the glycemic curves could be found.

The alkali reserve was studied in sixty patients. The conclusions drawn from this study are as follows: An alteration of the acid-base equilibrium was found in 75 per cent of the patients. The most frequent alteration, measured by means of determinations of the alkali reserve in blood plasma, is acidosis (65 per cent), a result that contradicts the observations of most investigators. This conclusion is corroborated by the fact that in numerous cases of marked acidosis the authors have seen after a short time, sometimes only after a few minutes, typical epileptic seizures. Patients suffering from essential epilepsy have acidosis. The alkali reserve after seizures is not constantly modified in the direction of increased acidosis. The perturbation of the acid-base equilibrium in epileptic subjects is not the cause of the alterations of carbohydrate metabolism. Epileptic patients react clinically with the production of convulsive crises irrespective of the direction of the perturbations of the acid-base equilibrium.

NONIDEZ, New York.

THE GROUPING AND TREATMENT OF ACUTE CEREBRAL TRAUMAS. CHARLES BAGLEY, JR., Arch. Surg. **18**:1078 (April) 1929.

Bagley reviews the cases of nineteen patients with cranial trauma. He discusses the grouping of cases of cranial trauma which he employs. This type of case is divided into seven groups: (1) Simple depressed fractures. The diagnosis in this group is made by inspection, palpation and roentgen examination of the skull and the neurologic disturbances indicating cortical injury. Early elevation of the bone fragments is indicated. (2) Compound fractures with or without depression. In these cases early operation is indicated to prevent infection and further damage to the cortex. (3) Extradural hemorrhage. The clinical picture of middle meningeal hemorrhage is well known. When this symptom complex is present, early operation is indicated. (4) Blood overlying the cortex. The symptoms in these cases depend on the size and extent of the clot. The treatment consists in drainage of the cerebrospinal fluid, which if commenced early can frequently be accomplished through repeated lumbar punctures. Subtemporal decompression may be necessary in some cases if a large clot is present or if evidence of increased pressure persists. (5) Cortical injuries. These are divided into three groups: cortical lacerations, diffuse superficial extravasations and single or multiple cortical clots. Again the symptoms depend on the portion of the cortex involved, and operation is often necessary to remove the clot and reduce pressure. These cases are all of a serious nature and the results of operation are often problematic. (6) Extravasations in the vein of Galen system. This is an infrequent type of lesion, characterized by rapid respiratory and pulse rates, hyperpyrexia, spastic musculature and abnormally low intracranial pressure with only a moderate disturbance of consciousness in the beginning. Operative treatment and therapeutic lumbar punctures avail little. The treatment, therefore, consists in the general care of the patient in the hope of preventing such complications as pneumonia. Patients who survive show residual symptoms. (7) Hemorrhage in the brain stem. The symptoms in these patients are similar to those in the previous group, but the cerebrospinal fluid pressure is not abnormally low and there may be no blood in the fluid, while in the previous group there is generally some staining of the cerebrospinal fluid. In the absence of symptoms of pressure, with clear cerebrospinal fluid, there is obviously nothing to be gained in subjecting these patients to operation. If the lesions are small, recovery may take place, but with a large hemorrhage or numerous scattered lesions the patients usually die.

GRANT, Philadelphia.

PUPILLARY DILATATION REFLEXES AND THEIR ABSENCE IN DEMENTIA PRAECOX. W. FEINSTEIN, Arch. f. Psychiat. **85**:329 (Oct.) 1928.

The author reports the results of an investigation of the Bumke syndrome in patients suffering with different diseases of the central nervous system. Following an extensive introduction with a detailed description of the anatomy and physiology of the pupillary reflexes, the author describes the Bumke syndrome

which consists in the absence or obvious diminution of three pupillary phenomena: the pupillary unrest, the dilatation of the pupils to psychic stimuli, and their dilatation to sensory stimuli. Bumke found that this syndrome was most frequently encountered in cases of dementia praecox of old standing. They were also to be found in some organic lesions (paresis, etc.), but here other organic neurologic signs would help to differentiate the cases from dementia praecox. Some authors have subsequently published results of their observations on this syndrome, and these results were not altogether uniform. Feinstein explains this variation on the basis of differences in technic. He himself examined his patients in a dark room which during the examination was illuminated by an electric light of uniform power. The dilatation reactions were examined with a binocular corneal lens. As psychic stimuli for dilatation he utilized mathematical problems which he varied with the intelligence level of the subjects. Pin pricks of the hands or neck were used as sensory stimuli. One hundred persons were examined. Twenty-seven of these had dementia praecox; fourteen had some organic disease of the central nervous system; five were manic-depressive patients; four were mentally defective, and five were psychoneurotic. The rest consisted of healthy persons used as controls. More than 50 per cent of dementia praecox patients showed a positive Bumke syndrome. This was found also in feebleminded persons and in those with organic brain disease, especially paresis. It was not found in the manic-depressive and normal persons.

The author comes to the conclusion that pupillary unrest and dilatation of the pupils to sensory and psychic stimuli are physiologic phenomena in man, and that disturbances of these are found in a high percentage of dementia praecox, advanced paresis and imbecility.

MALAMUD, Foxborough, Mass.

ROENTGEN THERAPY IN BRAIN AND CORD TUMORS. HEINRICH HIGIER, Der Nervenarzt **2**:79 (Feb.) 1929.

Higier is certain that neurologists have not given the subject of roentgen therapy sufficient consideration. He discusses the subject of roentgen therapy in detail, and suggests that a more thorough investigation of its possibilities be undertaken. There is little question that at present, with a localized cord or brain tumor, a surgical exploration with removal is by all means the method of choice. If, however, the new growth cannot be removed, or if a portion remains, roentgen therapy should be instituted. Roentgen therapy is also of special value in multiple lesions, or if the general status of the patient is such as to preclude surgical intervention.

Up to the present time the reports of roentgen therapy emanating from various clinics are unsatisfactory, as in some the reports are unusually good while in other equally good clinics the results have been rather unsatisfactory. It is these conflicting reports which has placed roentgen therapy in an unfavorable light.

Experimental work has demonstrated that nerve tissue, both cells and fibers, are radio resistive, and that no appreciable lesions, even after large doses, have appeared. If the experimental work is worthy of consideration, there is no excuse for neglecting these therapeutic measures. Undoubtedly, severe reactions occur following roentgen therapy, but as a rule such results are temporary and should but rarely constitute a cause for discontinuing treatment. Frequently, even in hopeless lesions, temporary relief is obtained, thus warranting its use.

In summing up his work, Higier believes that the x-rays can never replace the knife, but as an adjunct in postoperative and prophylactic treatment there has been much unnecessary neglect. In tumors in which exudative or adhesive processes are present, excellent results may be obtained when the surgeon would be comparatively helpless. It is the author's belief that in the careful use of roentgen therapy, in both brain and cord tumors, considerable temporary, and at times even permanent relief may be obtained.

MOERSCH, Rochester, Minn.

ON THE COMMUNICATIONS OF THE CEREBRAL CORTEX, ESPECIALLY OF THE FRONTAL LOBE, WITH THE NEOSTRIATUM AND PALEOSTRIATUM. L. COENEN, Encéphale **24**:1 (Jan.) 1929.

The investigations of previous workers on the communication between the cortex and the basal ganglia are briefly summarized. This includes Gudden, Fleschig, Wernicke, Wilson, the Vogts, Marinesco, Monakow and a few others. Then follow personal experiences of the author, in which rabbits were utilized. Minute sections of the cortex were cut away under aseptic precautions, and later degenerative studies were made. The conclusions are as follows: In the rabbit a communication exists between the cortex, the caudate nucleus and the globus pallidus. The fibers passing by the subcallosal fasciculus unite the area centralis, the area temporalis and the nucleus caudatus. The fibers follow in part the border of the internal capsule in gaining the interior of the caudate nucleus. There is a communication between the area temporalis and the globus pallidus by the fibers which enter the internal capsule from this area.

ANDERSON, Kansas City, Mo.

THE FATE OF HETEROPLASTIC GRAFTS OF THE FORE-LIMB LEVEL OF THE SPINAL CORD OF AMBLYSTOMA EMBRYOS. H. L. WIEMAN and T. C. NUSSMANN, J. Exper. Zool. **53**:45 (April 5) 1929.

Interchanging the region of the spinal cord from which the principal portion of the brachial plexus arises, in the embryos of *Amblystoma punctatum* and *Amblystoma tigrinum*, results in a functional and structural union between the graft and the nerve tissue of the host. The spinal nerves grow out to form a brachial plexus on each side. The foreign innervation has no appreciable effect on the rate and manner of development of the limb in stages of embryonic development up to the time of metamorphosis. These conclusions were indicated by the observations of experiments previously published, and the present paper consists of a description of three more cases which were fixed and stained by methods more appropriate for bringing out neurologic structure. The previous observations are confirmed.

WYMAN, Boston.

STUDIES IN ACROMEGALY: VIII. EXPERIMENTAL CANINE ACROMEGALY PRODUCED BY INJECTION OF ANTERIOR LOBE PITUITARY EXTRACT. TRACY J. PUTNAM, EDWARD B. BENEDICT and HAROLD M. TEEL, Arch. Surg. **18**:1708 (April) 1929.

A dog which received daily for fourteen months a sterile aqueous extract from the anterior lobe of beef hypophyses grew to almost twice the weight of its littermate control. It developed, among other conditions, enlargement of the acral parts, polyphagia, asthenia, sialorrhea and spontaneous lactation. The animal succumbed to myocardial failure and edema of the lungs. A skeletal overgrowth with hyperostosis was present. There was a generalized splanchnomegaly affecting the thyroid and genital tract most strikingly. The thyroid was hyperplastic; there were adenomas of the suprarenal gland and the ovaries contained ripe but unruptured follicles. The condition produced appears to merit the designation of experimental acromegaly.

GRANT, Philadelphia.

OPHTHALMOPLEGIA IN GRAVE'S DISEASE. A. M. WEDD and H. H. PERMAR, Am. J. M. Sc. **175**:733 (June) 1928.

A complete clinical and pathologic study of a case of exophthalmic goiter is reported in which symptoms began with a visual disturbance due to external ophthalmoplegia. Death occurred during a thyroid crisis. Consideration is given to the possibility that chronic progressive ophthalmoplegia and myasthenia gravis might have been present in this patient as separate disease entities together with disease of the thyroid gland. The postmortem examination revealed changes in

the thyroid which were believed to represent an exhausted state. There were also degenerative changes in both the suprarenal cortex and the thymus. The authors consider that the ophthalmoplegia in this case was a part of the exophthalmic syndrome and not an expression of a separate symptom complex.

WAGGONER, Philadelphia.

BLIND MICE. CLYDE E. KEELER, J. Exper. Zool. **51**:495 (Oct. 5) 1928.

The controversy as to whether or not the rodless eye serves as an organ of vision has placed at stake some of the fundamental conceptions of retinal structure and correlated function. The rodless retina of the house mouse is a hereditary condition, characterized by complete lack of rods and a greatly reduced external nuclear layer. All other portions of the retina, as well as the optic nerve, appear normal. Visual purple is absent. Training tests, supersensitization to stimuli, flash-light photographs, the inclined plane, and action-current measurements have failed to show any sensitivity in the rodless retina. Olfactory stimulation is suggested as an explanation of the paradoxic results obtained by Hopkins with both rodless and normal mice in his studies on intensity and color vision.

WYMAN, Boston.

TUMORS OF THE ACOUSTIC NERVE. JEAN MORELLE, Arch. Surg. **18**:1886 (April) 1929.

This study concerns an isolated tumor of the acoustic nerve probably developing from the distal portion of the cochlear division. The fibers of the acoustic nerve spread out over the surface of the tumor; they penetrated it rarely and only superficially, if one may judge from the myelin sheaths. Histologically, the tumor was formed of two tissues, reticular and fibrous, characteristic of acoustic tumors; their variable distribution in the tumor explains how the examination of a small fragment might lead to an erroneous histologic diagnosis. The case verifies the operative observation of a juxtapontile localization of the denser parts of the tumor. The method of Perdrau displays a special fibrillary formation which cannot be of either nervous or neuroglial nature.

GRANT, Philadelphia.

DIFFERENTIAL RELAXATION. Editorial, J. A. M. A. **91**:1465 (Nov. 10) 1928.

The problem of relaxation in these days of tension is one of great importance. The phenomena in connection with the knee reflex are briefly discussed. Jacobson has endeavored to ascertain whether there is a possibility of differential as contrasted with general relaxation in which practically all the skeletal muscles are relaxed. Can such activities as reading or writing proceed even if there is sufficient relaxation to produce a diminished knee reflex? Jacobson finds that the answer is positive. In neurotic persons, however, the decrease in the knee reflex often fails to occur; herein, one may have a possible test for nervous hypertension or neurosis.

CHAMBERS, Syracuse, N. Y.

SEPARATION OF GROWTH-PROMOTING HORMONE FROM THAT INDUCING PREMATURE ESTRUS IN THE ANTERIOR PITUITARY GLAND. TRACY JACKSON PUTNAM, Arch. Surg. **18**:1699 (April) 1929.

The residue left after extraction of beef anterior pituitary glands with mild alkalis, acids, alcohol and acetone is capable of producing premature estrus when implanted intraperitoneally in young rats or mice. This effect is apparently identical with that produced by homotransplants of rat anterior lobes into immature females, as observed by Smith and others. The effect appears to be distinct from that brought about by (alkaline) aqueous extracts from the same glands. It seems probable, therefore, that there are at least two chemically distinct hormones in the anterior pituitary gland, which may be separated in the manner indicated.

GRANT, Philadelphia.

TWO CASES OF PERIPHERAL NEURONITIS RESEMBLING LANDRY'S PARALYSIS. ROSS H. THOMPSON, Am. J. M. Sc. **175**:807 (June) 1928.

The author reports two cases in which there was an ascending type of paralysis. In one case a serum made from an old case of poliomyelitis was injected intraspinally. Both patients recovered completely after a period of some weeks. The first case is considered to be a true Landry's paralysis with recovery, and the second a case of ascending symmetrical polyneuritis with involvement of the cranial nerves. The pathologic condition is assumed to be an involvement, probably toxic in character, of the entire peripheral motor neuron but not to the point of cell destruction or permanent damage.

WAGGONER, Philadelphia.

MYDRIASIS AND ANGIOSPASM OF THE RETINAL ARTERIES CAUSED BY METAL INTRA-OCULAR FOREIGN BODIES. CHARLES LAFON, Ann. d'ocul. **165**:15 (Jan.) 1928.

Lafon reports that a patient with unilateral mydriasis and angiospasm of the retinal arteries had a foreign body of steel in the affected eye. He believes that the irritation produced by the intra-ocular foreign body caused the mydriasis and angiospasm, and suggests that the retinal vessels may have their own special sympathetic innervation. He calls attention to the fact that irritation of the cervical sympathetic system produces unilateral mydriasis and constriction of the arteries of the face.

BERENS, New York.

EXPERIMENTAL DIABETES INSIPIDUS. E. B. TOWNE, Arch. Surg. **18**:1165 (April) 1929.

Towne attempted to produce diabetes insipidus in dogs by detaching the stalk of the pituitary gland. He found that the polyuria thus produced was transitory. He has searched through the literature and found that separation of the stalk rarely if ever produced permanent polyuria. From his experiments and from the literature he feels that the neurogenic theory of Camus and Roussy is not supported. He believes that these experiments strongly suggest that diabetes insipidus is due to suppression of the secretion of the pars intermedia and the pars tuberalis.

GRANT, Philadelphia.

THE EYE OF THE TAUPE AND THE PROBLEMS WHICH IT BRINGS UP. A. ROCHON-DUVIGNEAUD, Ann. d'ocul. **165**:801 (Nov.) 1928.

How is it that a sense which appears so essential to us can be reduced in certain animals to the status of an accessory sense or be entirely absent? The problem is two-fold: The first is physiologic. What are the anatomic and functional modifications which permit the existence of a mammal deprived of sight? The other aspect of the problem is that of the origin. How is it that an anomaly such as this could be developed? What is the origin of all the modifications which the animal must undergo in order to live without sight?

BERENS, New York.

RAYNAUD'S DISEASE ASSOCIATED WITH CANCER OF THE STOMACH. T. I. BENNETT and E. P. POULTON, Am. J. M. Sc. **176**:654 (Nov.) 1928.

The authors report the case of a man, aged 60, who had begun to have pain in his fingers three months before examination. He presented a fairly typical Raynaud's syndrome. Sympathectomy was performed; the patient died during the operation. At autopsy a large gastric carcinoma was found. Tumor cells were noted in the inferior cervical sympathetic ganglion. These cells were supposed to have produced sympathetic stimulation and thus to have been the cause of Raynaud's disease in this case. A case with similar clinical features was found in the literature.

WAGGONER, Philadelphia.

Society Transactions

NEW YORK ACADEMY OF MEDICINE, SECTION OF NEUROLOGY AND PSYCHIATRY

Feb. 12, 1929

JUNIUS W. STEPHENSON, M.D., *Chairman*

A CASE OF OXYCEPHALY. DR. SAMUEL ATKIN.

A Russian Jew, aged 36, came to the Vanderbilt Clinic complaining of: defective vision since childhood, which had been rapidly failing since the summer of 1928; prominence of both eyes all his life; increasing left-sided deafness for three years; slight right-sided deafness for one year; insomnia for two years; frequent urination for one year and headaches over the right parietal region for ten years. The peculiar shape of his head was first noticed after a fall, at the age of 6 months, which was not followed by unconsciousness. The heads of the other members of the family were normal in shape.

Physical Examination.—The patient was well developed and of medium height. His head was domelike with a high, receding and flattened forehead, with a normally prominent glabella and brow ridges. The face was flat and asymmetrical, the right side being more developed than the left. The nose was prominent. The occiput was vertical and flattened with a small external occipital protuberance. Head measurements were: cephalic length, 18.4 cm.; cephalic breadth, 15 cm.; cephalic index, 82 (mesocephalic head); head height, 13 cm.; length-height index, 70. The mentality was normal. Except for a slight enlargement of the isthmus of the thyroid the general physical examination gave negative results.

Neurologic examination gave negative results, except for a fine, rapid tremor of the fingers and partial left nerve deafness.

Ophthalmologic Examination.—There was bilateral optic atrophy. With correction, the vision in the right eye was 12/200; in the left 15/200. The visual fields were markedly contracted. Central color vision was defective. There was a central scotoma around the blind spot of each eye. There was marked exotropia for far as well as for near vision. Bilateral exophthalmus was present and was more marked on the right.

Roentgenologic Examination.—The cranial bones were irregular and thickened. The frontal region was thin and presented prominent interconvolutional ridges with localized bone atrophy of the inner table; the orbits and optic foramina were normal; the sella turcica was deep and widened; the base of the skull was platybasic. The coronal suture was obliterated and the sphenoid sinus was smaller than normal.

All laboratory observations were normal.

Comments.—Oxycephaly is a characteristic deformity of the skull due to premature craniosynostosis, usually accompanied by ocular disturbances, the most common being exophthalmus, divergent strabismus, optic atrophy and nystagmoid movements. Headaches, loss of smell and impaired hearing may occur. The mentality is usually normal. The sutures first involved are the coronal, lambdoid and parietal, although in true oxycephaly all cranial sutures eventually become affected. The cranial vault is dome-shaped, the head being usually brachycephalic, the orbits shallow, the middle cranial fossa depressed and the accessory nasal sinuses partially obliterated. There may also be facial asymmetry.

Meningitis, syphilis and rickets have been advanced as causes of premature craniosynostosis, but without substantial proof. True oxycephaly is most probably a congenital malformation. Owing to its frequent occurrence at birth and its

association with other developmental malformations, this theory seems plausible. The secondary optic atrophy is attributed to increased intracranial pressure, but the disturbances in the anatomic relationships of the optic nerves are largely responsible for their stretching and kinking. The exophthalmus is in some cases attributed to the shallowness of the orbits.

The unusual features in the case presented are the patches of destruction in the inner table of the skull and the presence of exophthalmus with normally deep orbits. The association of a rather mild form of oxycephaly with such severe symptoms is also noteworthy.

DISCUSSION

DR. C. A. LEWALD: I am sorry that I did not bring along some slides of two cases that I have seen in which the condition was marked. Dr. Elsberg saw one of them with me in St. Luke's Hospital. The shape of the skull and thinning of the cranial bones with the absence of suture lines, I believe, are characteristic of the condition, and I should regard the case presented as belonging to the less severe forms of oxycephaly.

DR. H. A. RILEY: When this patient first came to the Neurological Institute, Dr. Atkin asked me to see him. At that time the peculiar association of the shape of the head with the neurologic signs made me believe that the condition might be due to the cranial deformity similar to that described under the term oxycephaly.

I am not discouraged at the failure of anthropologists and craniologists to reach the same conclusions as we did. I believe that the diagnosis of oxycephaly can be made as much on the associated neurologic signs and symptoms as on any decided change in the outline of the skull.

Some change in the cranial vault, of course, must be present to produce unusual stresses and strains within the cranial cavity.

In examining this patient, it occurred to me that the optic atrophy and the involvement of other cranial nerves might be due to the peculiar angles produced by the shortening of the base and increase in the vertical diameter of the skull, associated with the normal movements of the brain during respiration and to a certain extent during the circulatory phases. A number of patients have come under my observation, over a period of years, presenting late evidences of trauma, due to structural defects and deformities. I remember one patient at the Vanderbilt Clinic who had had a fracture of the external condyle of the humerus at the age of 6 years. He had suffered from no disturbance whatever in ulnar function until he was about 38, when he developed definite pressure signs and presented a perfectly typical ulnar nerve syndrome. This would clearly indicate that constant and persistent trauma producing abnormal neural stress or strain may occur and exist over a period of thirty years before producing definite nerve changes. It seems to me that the same cause might be invoked in this situation. We know that the optic foramina are not encroached on. There is no reason to believe that this patient has ever had any material increase in intracranial pressure. He has never presented any general symptoms of increased intracranial pressure, and the optic nerve change appears to be an optic atrophy not consequent on a papillitis or papilledema.

I believe that the optic nerve atrophy with the restriction and diminution in the visual fields may be the late result of a long continued trauma exerted on the optic nerves in their course from the optic foramina upward to the base of the brain.

CASES OF TUMOR OF THE BRAIN REMOVED AT OPERATION, WITH A LANTERN SLIDE DEMONSTRATION OF RESULTS OBTAINED IN THE REMOVAL OF INFILTRATING TUMORS OF THE BRAIN BY THE AID OF ELECTROSURGERY. DR. CHARLES A. ELSBERG.

The first patient presented was a woman with a history of two months' duration and with advanced signs of tumor in the right temporal lobe. The patient was suffering from severe headache, had a homonymous hemianopia and marked pyramidal tract signs on the left. At operation, a large part of the right temporal

lobe was removed under local anesthesia with the electrosurgical knife. The patient recovered satisfactorily from the operation, and the fields improved greatly. Recently her headaches have recurred and, as the pathologic report was that of a spongioblastoma, the chances that the tumor is recurring are great.

A second patient was presented in whom a large meningioma on the under surface of the right frontal and temporal lobes attached to the dura over the cavernous sinus had been removed with the electrosurgical knife through the right frontal lobe. The predominant symptoms in this case were mental disturbances, facetiousness, headache and a low grade of papilledema. An operation had been done by another surgeon, but the tumor had not been exposed. Through a large osteoplastic flap, the attempt was made to reach the growth underneath the frontal and temporal lobes, but the tumor lay so far mesially, and was so large that the intracranial pressure was too high to permit elevation of the brain. A large incision was therefore made through the right frontal lobe and the tumor exposed on the surface of the frontal lobes. It was gradually removed in fragments by means of the electrified loop. The patient presented was in good condition four months after the operation. Her mental symptoms had mostly disappeared and the disks were flat. The speaker declared that this tumor could not have been removed without the use of an electrosurgical knife.

The third case was that of a boy, aged 11, who had symptoms of a lesion in the left cerebellar hemisphere. At operation, a large infiltrating astrocytoma, which extended deeply into the cerebellar lobe and worm, almost into the fourth ventricle, was widely excised by means of the electrosurgical knife. The patient had recovered rapidly from the operation, and it was remarkable that in spite of the excision of a large part of the left cerebellar lobe, the cerebellar symptoms had disappeared rapidly. The morning after the operation the nystagmus had almost disappeared as did the marked ataxia that had existed before the operation. This case was an example of the small amount of trauma to brain tissue when the latter is incised and excised by electrosurgical methods.

The fourth case was that of a boy, aged 19, who had been admitted into the hospital almost blind from papilledema with signs and symptoms of a suprasellar tumor. A large transfrontal flap was turned down, the frontal and temporal lobes were elevated and a tumor 3 by 2 cm. was removed from above the pituitary fossa. The tumor was reported as an adenocarcinoma of the pituitary. The patient had recovered all his vision, and the symptoms which he had before the operation had entirely disappeared. What was unusual was that before operation, the boy had a large amount of hair over his face, body and extremities, all of which had disappeared within a few months of the operation. (Lantern slides were shown demonstrating the appearance of the patient before and after the operation.)

In connection with these four patients, the speaker showed a large number of lantern slides of the conditions found at operation in patients with infiltrating tumors of the brain which had been successfully excised by means of electrosurgical methods. There is no question that by the use of electrosurgery, tumors can be removed with less trauma to the brain, and far more successfully than was ever possible before. The outlook for better results in the excision of infiltrating growths has been greatly furthered by this new method.

DISCUSSION

DR. GLOBUS: Dr. Elsberg is probably interested in my opinion as to the histologic character of some of the tumors. I am prepared to speak about only two of the cases presented. One, it will be recalled, was described as a gliogenous tumor. I use the term gliogenous when I am unable to decide whether the tumor is benign or malignant. However, when I say gliogenous, I am more inclined to a malignant character, or else I report it as an astrocytoma or benign glioma. I think that the recent clinical changes in that patient seem to justify my unwillingness to regard that tumor as benign.

Astrocytomas are reported somewhat too frequently. Many of the astrocytomas that have been reported from other laboratories are not astrocytomas. I think

that some of them are meningiomas. Meningiomas at times are difficult to recognize histologically, especially when only small fragments of the tumor are available for histologic study. It is difficult to differentiate them from astrocytomas unless special stains are employed. A good illustration of that is the last case shown by Dr. Elsberg. The growth appeared histologically as a "malignant" type of meningioma, if it can be so labelled. I was inclined to call it a sarcomatous meningioma—a meningioma with a rather rich cellular make-up. Indeed, it showed some features not unlike those seen in astrocytomas. The picture shown by Dr. Elsberg in the second case revealed the smooth surface of that tumor and a clean cavity from which it was removed, which is another point supporting my belief that the tumor belongs to the meningiomas.

Dr. E. D. Friedman: Dr. Elsberg has demonstrated that something really can be done for selected cases of brain tumor. I shall confine my remarks to two of the cases. The first patient presented by Dr. Elsberg came to the hospital with euphoria and facetiousness—symptoms suggestive of a frontal lobe lesion. There were few other localizing signs. There was a distinct bilateral papilledema, with some bilateral impairment of the sense of smell. The latter was practically the only clue to the possible localization of the growth. Because of the paucity of clinical observations, lumbar encephalography was performed; it gave a rather clear picture of the localization of the neoplasm. In the anteroposterior view the normal ventricles assumed approximately the shape of a "butterfly." In this patient the lower poles of the anterior horns were blotted out, and a picture similar to that in the normal postero-anterior view (a "ram's horns" figure) was obtained. In fact, on first looking at the plates, we thought we were dealing with a postero-anterior view. The radiographer was sure of his markings and after studying the lateral plates we felt certain of the localization; in the lateral plate we observed the indentation of the lateral ventricle by a mass growing up from below. On the basis of the encephalographic observations the diagnosis of an infrafrontal neoplasm was made, and transfrontal exploration was advised. The surgeon could not locate the growth. Dr. Elsberg later operated on this patient and by cutting through the right frontal lobe succeeded in locating the neoplasm which he has already described to you.

This case is a good illustration of the value of the encephalogram in clinical neurology. Even in the presence of a high degree of papilledema, lumbar encephalography is a fairly safe procedure. This patient exhibited pronounced papilledema. She stood the procedure well and presented few after effects.

Finally, I shall say a word about the patient to whom Dr. Globus referred as a case of sarcomatous meningioma. This man presented a symptom which Dr. Elsberg and I have frequently observed in some cases of cerebral neoplasm, namely, a facial palsy of the supranuclear variety which is severe, and seems peripheral in type. I have seen it in a number of instances of temporal lobe neoplasm. The electrical reactions in these cases are normal; there is, therefore, no question of distal pressure on the facial nerve. It is my impression that in these growths we are dealing with a combination of voluntary and mimetic facial palsy, the latter being due to distant pressure on the thalamus. We then observe a complete facial palsy which resembles a peripheral palsy, but is not of this type. I have seen this symptom frequently enough to make it an interesting clinical observation.

Dr. Elsberg: While from the depth of pathologic ignorance I look up with the highest regard to the neuropathologic acumen and knowledge of Dr. Globus, still, in the patient in whom he reported the tumor as a sarcomatous meningioma, it goes beyond my understanding how a tumor which had no relation to the dura, which lay in and under the cortex and infiltrated the cortex deeply, which had cystic cavities in it, could still be a true meningeal tumor. It presented none of the characteristics at operation that I have ever seen in a meningeal fibroblastoma or meningioma or endothelioma, whatever one desires to call it.

Dr. Globus: The case in question may still be called a meningioma since a small number of such tumors have their origin in the pia. They need not be related to the dura at all. It is this type of tumor which often invades brain tissue.

SYPHILITIC MENINGO-ENCEPHALITIS WITH HEMORRHAGES IN THE LEPTOMENINGES. DR. IRVING J. SANDS.

The syndrome of subarachnoid hemorrhage is becoming of increasing interest to neurologists because it is being recognized more readily. Following an effusion of blood into the subarachnoid space there may appear increased intracranial pressure with headache, vomiting and convulsions. As a result of the meningeal irritation, there may occur rigidity of the neck, a positive Kernig sign and diminished deep reflexes. The blood may invade the sheaths of the optic nerves with blurring of the margins of the disks, and even retinal hemorrhages. The spinal fluid is uniformly bloody if collected in several test tubes, does not clot, and, when centrifugated, the supernatant fluid still remains colored, differing in these respects from the bloody spinal fluid due to trauma during lumbar puncture. Leukocytosis and mild elevation in temperature ensue. One of the causes of subarachnoid hemorrhage may be rupture of a degenerated syphilitic pial vessel. The following two cases are illustrative:

CASE 1.—A white, married woman, aged 40, was taken suddenly ill with headache and drowsiness in the early part of November, 1927. She occasionally saw double. Examination revealed: irregular pupils, the right being fixed and the left reacting sluggishly; moderate rigidity of the neck, and a suggestive Kernig sign. The spinal fluid was bloody; the supernatant fluid was golden yellow, and gave a four plus Wassermann reaction. The Wassermann reaction of the blood was one plus. The husband took her to another physician who obtained a negative Wassermann reaction of the blood. On the basis of that report the husband was assured that his wife had no syphilis, and a sea voyage was advised as a therapeutic measure. Six hours after reaching a hotel in Bermuda, the patient was found unconscious in the bathroom. On Jan. 11, 1928, she was brought back to this country. On arrival she complained of pain in the suboccipital region, small of the back and calf muscles, and extreme vertigo on changing the position of the head. The left pupil was larger than the right and almost fixed to light and in accommodation; a moderate right supranuclear facial weakness; a positive Kernig sign with slight rigidity of the neck and diminished deep reflexes. The spinal fluid was bloody. The Wassermann reaction in the blood was two plus, in the spinal fluid four plus. The temperature was 100.4 F. There was a moderate leukocytosis. Six days later, blurring of the disks and engorgement of the retinal vessels were noted. On January 27, she was given 1 decigram of sulpharsphenamine intravenously, following which she developed a rash and a temperature of 102 F. These subsided in a few days. She was then given spinal drainage every second day, and hypertonic solutions of dextrose intravenously. On February 6, she had a convulsion. On February 17, 1 decigram of sulpharsphenamine was again administered intravenously; this was also followed by a rash and a rise in temperature. She gradually improved and was discharged from the hospital on February 27. She is now fully able to take care of her household and social duties.

CASE 2.—A white, married man, aged 37, the father of three children, was admitted to the hospital on Jan. 30, 1928, with the history that for the past ten years he had been suffering from pain in the back and lower extremities during inclement weather. During the latter part of December, 1927, he began to suffer from headache and a tendency to drowsiness. On Jan. 23, 1928, he vomited several times. On the following day he suddenly collapsed, and was unconscious for a few hours. Physical examination on admission disclosed irregular, unequal pupils of the Argyll-Robertson type. Both disks were blurred. There were: a slight facial weakness, rigidity of the neck, and positive Kernig and Brudzinski signs. The deep reflexes were depressed. The calves were tender on deep pressure. The blood showed 11,000 white cells and 82 per cent polymorphonuclears. The Wassermann reaction in the blood and spinal fluid was four plus. The spinal fluid was bloody. The temperature varied between 100 and 101 F. Under treatment consisting of spinal drainage and intravenous injections of dextrose, the patient made a satisfactory convalescence. He was considered suitable for discharge when he suddenly had a convulsion and died, twenty-nine days after admission.

Necropsy revealed fluid and clotted blood in the middle and posterior cranial fossae. The base of the brain was covered with blood, especially in the interpeduncular space and in the great cisterns. The fourth ventricle was also filled with blood. There was extensive hemorrhage in the temporal and parietal regions of the brain. Microscopic examination showed a typical syphilitic encephalitic reaction, with chromatolysis of the ganglion cells, satellitosis and neuronophagy. The cortical vessels showed infiltration of the Virchow-Robin lymph spaces with lymphocytes and plasma cells. There was considerable neuroglial reaction. The pia-arachnoid was infiltrated with lymphocytes and plasma cells, and showed a moderate fibroblastic reaction. The pial vessels showed syphilitic endarteritis. The subarachnoid space contained free blood.

DISCUSSION

DR. ARMANDO FERRARO: I shall discuss two features: (1) The emphasis that we must bring on the occurrence of endarteritis, especially of the small blood vessels, which is an important factor in the pathology of neurosyphilis.

(2) The fact that subarachnoid hemorrhage may occur in syphilitic conditions. As a matter of fact, statistics as to the occurrence of subarachnoid hemorrhage in syphilis are meager. These cases have not been reported frequently, and Dr. Sands' cases add to the statistics of the occurrence of subarachnoid hemorrhage in syphilis. They also point to the necessity of spinal puncture in cases of convulsive disorders in syphilitic disease in order to determine whether a subarachnoid hemorrhage has occurred.

The second part of my discussion I shall devote to designation of the cases presented by Dr. Sands. He calls them syphilitic hemorrhagic meningo-encephalitis. I am afraid this designation might lead to confusion with encephalitic hemorrhagic condition, by which we mean a particular process represented by the appearance of minute hemorrhages through the entire brain parenchyma, especially in the white substance. In these cases the histology of the small foci is definite—it consists of a perivascular necrosis surrounded by a ring of white blood cells.

In the cases presented by Dr. Sands, we have, as a matter of fact, only a subarachnoid hemorrhage, and I have not heard any report as to the presence of small hemorrhagic foci in the brain itself. I wonder if it would not be better to use the designation of "syphilis with hemorrhagic meningitis" for these cases, rather than the name he employs.

DR. LEON H. CORNWALL: I, too, would be more satisfied if Dr. Sands would be willing to designate these as cases of syphilitic meningo-encephalitis, with associated leptomeningeal hemorrhage.

I think that he has demonstrated clearly that these are cases of syphilitic meningo-encephalitis. The frequency of leptomeningeal hemorrhage in association with syphilis is sufficiently low, I think, to warrant a little caution before deciding that syphilis was necessarily the factor responsible for the hemorrhage.

There are two other points, however, that are of particular interest to me. I welcome the opportunity to speak a word of caution concerning the intravenous use of sulpharsphenamine. This drug has contributed one thing to the armamentarium for the treatment for syphilis, and that is its availability for intramuscular administration in certain cases in which one desires to administer arsenic and this cannot be done intravenously. Some preparations of sulpharsphenamine are toxic, especially when administered intravenously, and I believe that this fact deserves emphasis.

There has come to my attention within the last three months a case of sudden death following a small dose of this drug. Death occurred within twelve hours after the intravenous administration of 0.15 Gm. The medical examiner ascribed the fatality to acute arsenical poisoning.

On inquiry from some chemists who were thoroughly in touch with the arsenical problem, I learned that this was not so uncommon as one might think and that a considerable number of sudden deaths in various parts of the United States had been attributed to this drug. I would repeat again that the intravenous use of

sulpharsphenamine is dangerous, and I know of no advantage that it serves. Silver arsphenamine possesses all of the advantages desired and has a low index of toxicity.

The second point has to do with the therapy. I am not entirely in accord with Dr. Sands concerning the danger of repeated lumbar punctures in cases of leptomeningeal hemorrhage that represent a slow seepage. I am in accord with him that immediately after a cerebral episode of this sort a puncture is not indicated and, of course, in the case of a rupture of a basilar aneurysm a puncture may actually augment the hemorrhage.

In leptomeningeal hemorrhage due to a slow seepage of blood into the subarachnoid space it has been my experience that the blood clears up after repeated lumbar punctures and that they are the indicated therapeutic procedures.

DR. GLOBUS: I, too, agree with Dr. Ferraro that the term meningo-encephalitis hemorrhagica is not a good designation for these two cases. The cases are exceedingly instructive and illustrate the disease entity which neurologists have come to know as "subarachnoid hemorrhage." A careful investigation of the vessels should be made. They may disclose an aneurysm which had ruptured. Perhaps a small one, but certainly there must be an aneurysm of the vessels at the base of the brain to cause extravasion.

Sudden headache, marked meningeal signs and the presence of free blood in the spinal fluid are striking symptoms in this syndrome. The presence of blood within the fourth ventricle, which Dr. Sands, I think, regarded as an independent bleeding from a vessel in the fourth ventricle, I believe is a retrograde flow of blood which entered the subarachnoid space and then by way of the foramina of Magendie had entered the fourth ventricle which likely caused the fatal termination.

DR. OSNATO: May I ask Dr. Sands if there was a history of alcoholism in any of these cases?

DR. SANDS: In reply to Dr. Osnato, I can say that neither one was a drinker.

I am ready to accept the criticism of the title of my paper. I was not pleased with it myself, but could not find a better one. I knew that these cases were essentially syphilitic meningo-encephalitis, with hemorrhage in the leptomeninges. I tried to get an appropriate designation for them. Obviously I failed. I shall publish the paper under the title of "Syphilitic Meningo-Encephalitis with Hemorrhage in the Leptomeninges." I cannot agree with Dr. Globus that it is always possible to find a ruptured aneurysm in these cases. In a paper on intraventricular hemorrhage (*J. Nerv. & Ment. Dis.* **65**:360, 1927) I reported three cases, and in only one was I able to demonstrate the aneurysm. In fact, I had spent two weeks on one of them in my effort to locate the ruptured vessel or aneurysm, and I failed. The experience of other writers on this subject will bear me out on this point. I do not think that the hemorrhage in the fourth ventricle was an independent one, although it is possible that it may have been. I believe that the blood got there by return flow from the subarachnoid space. Dr. Cornwall's comment on the toxicity of sulpharsphenamine is instructive and interesting. I never had regarded the drug in such a light. Until a year ago, I had used this drug to the exclusion of others, and had never experienced any ill effects from it. I employed it in the patient reported tonight after consultation with able physicians, one of whom is an eminent syphilologist.

TUMORS OF THE SPINAL CORD. PROBLEMS IN THEIR DIAGNOSIS AND LOCALIZATION. PROCEDURES FOR THEIR EXPOSURE AND REMOVAL. DR. CHARLES A. ELSBERG.

This paper appears in full in this issue.

DISCUSSION

DR. FRIEDMAN: Dr. Elsberg has given a delightful and rapid survey of the field of spinal cord diagnosis. His stressing the incidence of nystagmus in cases of tumor of the spinal cord is important, especially in the differential diagnosis of

spinal cord tumor and multiple sclerosis. Serko, many years ago, postulated the thesis that one may encounter nystagmus in tumors of the spinal cord located as low down as the upper dorsal zone. Most neurologists are now agreed that the incidence of nystagmus in cases with symptoms suggestive of a level lesion in the upper cervical cord does not militate against the diagnosis of spinal cord tumor.

In some cases of high cervical cord tumor, stiff carriage of the head may be observed. The neck is immobilized.

In the Neurological Department of Bellevue Hospital we have observed one case of high cervical tumor in which the existence of an external rectus palsy complicated the clinical picture. It disappeared after laminectomy. Several months ago I read before this section a paper on tumors of the upper cervical cord which presented the syndrome of combined system disease.

The dissociation between tactile and spinothalamic sensation, of which Dr. Elsberg has spoken, is important. I have found another type of dissociation, namely, the early exclusive involvement of posterior column sensation. Owing to the fact that the suboccipital space is large, tumors in this region will give rise early in their course to disturbances in that form of sensation which is phylogenetically recently acquired, namely, gnostic sensation, while so-called vital sensation (pain and temperature) remains intact for a long time. In the later stages, with increasing encroachment on the cord substance, these fibers also become involved, and the sensory changes then become complete.

The questions of the signs of a shifting level to which Dr. Elsberg has referred interest me much. For a number of years I have felt that the slow ascent of the sensory disturbances from the sacral area to the level of the lesion indicates extramedullary compression of the cord from side to side.

This subject was discussed many years ago by Serko. Later on, Foerster, Marburg, Elsberg, Tilney and others made contributions to this subject. We now know that there must be lamellation in the spinothalamic pathway, the sacral fibers occupying a peripheral position in this tract. As the transverse pressure increases the sensory disturbances ascend toward the level of the lesion and ultimately reach the level of the compressing growth.

I believe, too, that the theory which Dr. Elsberg has advanced concerning the difficulty in localizing anteroposterior growths by means of the sensory disturbances is logical. I should like to modify it to some extent and to say that in anteroposterior compression of the cord, the disturbance in spinothalamic sensation is apt to take on the form of exclusion of the sacral area, much like that observed in intramedullary growths.

Serko thought that the sacral areas were spared owing to the fact that they constitute a vegetative zone, a very primitive zone, which retains its sensation longer than other parts of the body. I believe that this explanation is probably not correct and that these anomalous sensory disturbances can be best explained on the theory of lamellation of the fibers in the spinothalamic pathways.

DR. GLOBUS: I believe that many a seasoned neurologist will carry away an interesting new point of view after having heard Dr. Elsberg. There is one problem which he has not mentioned at all, about which he was anxious to speak. It is about the advantages of iodolography, the injection of iodized poppy seed oil 40 per cent into the subarachnoid space for the localization of spinal cord tumors. I know that Dr. Elsberg, and he will likely bring it out in his concluding remarks, objects to the injection of iodized oil for the localization of spinal cord tumors. The midthoracic spinal cord tumors with their shifting levels, where localization by the ordinary methods is rather difficult, constitute a large number of instances in which iodized oil is of great service. There are other tumors at higher and lower levels where iodized oil has been of great service when employed in addition to the other neurologic methods.

DR. ELSBERG: I shall take up the question of iodized oil just for a moment. I am by no means objecting to iodized oil in the cases in which it is needed. I do feel strongly that iodized oil is an irritating substance. I have again and again

seen the roots of the cauda equina deeply inflamed and covered by fresh fibrin. I have seen the surface of the cord itself red and congested.

If I had a suspected spinal cord tumor—unless it was one of the class of cases that I shall mention in a moment—I would take my chances with a diagnosis by Dr. Globus or some other good neurologist. I believe that iodized oil should not be used in every instance. I think that with careful examinations and careful manometric tests iodized oil need rarely be used, and that only when careful examinations made both before and after lumbar puncture cannot allow one to determine the level of the disease.

We do not need iodized oil in order to make a diagnosis of subarachnoid block, because careful manometric examinations will settle that once for all. It is only in a rare instance when a level cannot be determined either somewhere along the cord or over the conus and between the roots of the cauda equina, when one does not know whether the tumor is lying on the cord near the origin of nerve roots or lower down near the exit of the nerve roots through their foramina. In these patients iodized oil is of decisive value for the surgeon in order to tell whether laminectomy is to be performed higher up or lower down.

I believe that in from 80 to 90 per cent of spinal cord tumors careful examinations and careful manometric tests are sufficient to make a localizing diagnosis so that the operation can be done at the proper level. With these limitations I agree with what Dr. Globus has said.

NEW YORK NEUROLOGICAL SOCIETY

Regular Meeting, March 5, 1929

LOUIS CASAMAJOR, M.D., *President, in the Chair*

NOTES ON A CASE OF HEMIPLEGIA FOLLOWING ENCEPHALOGRAPHY. DR. CHARLES ROSENHECK.

This article appears in full in the September issue, p. 575.

THE AMELIORATION OF MENTAL DISEASE BY INFLUENZA. DR. KARL A. MENNINGER.

Influenza has wrought so much evil that any suggestion of its possible beneficence should be as welcome as it is extraordinary. From the casuistic standpoint, the phenomena about to be discussed are negligible. But that any somatic disease may influence any mental disease favorably is a matter of great theoretical and some practical importance. Theoretically, this involves all the questions of the interrelations of psychic and somatic disease, and the question of reversibility in mental illness. Practically, all sorts of treatment rationale depend on the proper interpretation of the phenomena. This includes not only those methods which utilize artificial means of producing physical disease, including malarial therapy for paresis, but it relates as well to the whole problem of environmental modifications, and even such technical aspects of psychotherapy as the "active therapy" moves of psychoanalysis.

That it is a fact of reported observation that somatic disease may favorably affect preexisting psychotic manifestations should not require much evidence here, but the precise delimitation of the observed "facts," the present status of the data relative to the problem, deserves restatement. Symptom manifestations of mental disease, i.e., "attacks of mental disease," are sometimes (1) precipitated by somatic infectious disease; (2) aggravated by somatic infectious disease, or (3) ameliorated by somatic infectious disease. Of the first two manifestations it is known that all types of mental disease and all types of infections are included; for example, one knows that influenza may precipitate or aggravate all known types of mental disease pictures. Schizophrenia, for example, may be provoked into external expression by many agents, including any and all infectious diseases.

In regard to the third manifestation, the amelioration process, there is evidence in the literature, examples of which are cited, that various of these mental disease pictures (especially melancholia, mania, confusional psychosis, hebephrenia, catatonia, paranoia, schizophrenia, epilepsy, idiocy and paresis) may be favorably affected by one of the following infections: typhoid, typhus, recurrent, scarlet or rheumatic fevers; smallpox, angina, pneumonia, pleurisy, abscesses, erysipelas, diphtheria, measles, cholera, dysentery, malaria and influenza.

The particular interest of this paper is concerned with influenza, and with specific instances of its ameliorative effects on mental diseases. Its deleterious effects are so many and so well known that this should make more interesting its function in the opposite direction. The literature on influenzal amelioration of mental diseases, together with cases of my own observation and an analysis of these cases, is given. My cases include a case of epilepsy in which a cure was effected; an epileptic psychosis, with remission, a second case of epilepsy with improvement and remission; a case of chronic mania, with remission; a case of migraine in a man, aged 35, who was cured, and a case of idiocy, with marked improvement. The case analysis reveals that in the observed cases there were 9 males, 7 females and 4 patients whose sex was unknown; that the duration of the psychosis was from one to one and one-half years in 7 cases; from two to four years in 3 cases; from five to fifteen years in 6 cases, and of unknown length in 4 instances. The results showed that 13 patients were considered cured, 3 improved and in 4 remissions were obtained. The diagnoses were: mania, 3; melancholia, 2; unknown, 2. The diagnoses in the cases reported as cured were: mania, 1; melancholia, 2; schizophrenia, 4; organic lesion of the brain, 1; epilepsy, 2; migraine, 1; unknown, 2. From so small a series no statistical conclusions can be drawn, but it is apparent that both sexes, various syndromes and illnesses of variable duration are included.

A consideration of the theoretical implications of the mechanisms of the process includes the chemical theory, holding that the result is achieved by the neutralization of primary toxins by the antibodies of secondary toxins; the physical theory, advanced by Courbon on an anatomic basis; the humoral theory, advanced by Leroy, and the catalytic theory, suggested by me, which holds that from a purely mechanistic standpoint the process closely parallels the phenomenon of catalysis. An enzyme, or other catalytic agent, acts to accelerate certain reactions in a direction in which they were already slowly moving. No change in energy relations takes place and the catalytic agent does not enter into the reaction. The same catalytic agent which promotes a reaction in a certain direction may effect the reversibility of the reaction, i.e., may promote it in exactly the opposite direction, under certain environmental conditions. This is what appears to occur in the problem under consideration. Infectious disease is known to hasten disintegrative processes and tendencies of certain personalities, occasionally to the point of breaking, i.e., of breaking out, as it were. Just how it accomplishes this is unknown. It is inadequate to refer to the "toxic effects on the cerebrum" because in the first place there is no proof that the cerebrum is affected by these toxins, and secondly, it is not known exactly what are meant by "toxic effects." What is known is that a certain mass reaction occasionally follows, and much less frequently precisely the opposite reaction occurs. This is submitted as an exact parallel to catalysis.

The psychologic factors are probably identical with those which are operative in posttraumatic cures. Recoveries following accidents, hemorrhages, parturition, suicidal attempts, legal crises, surgical operations, injections of spinal serum, Kaufmann's "Überrumpelung" cure, etc., are probably all to be regarded as accomplishing a reconciliation of the distraught and warring processes of the unconscious with a declaration of peace. The gratification of Freud's recently postulated death instinct, the assuaging of the demand for propitiatory suffering of an unconscious sense of guilt, the threat to the extinction of the ego, these and many other possibilities appear which could be identified only by penetrative study of individual cases.

A corrolary problem is raised, which may throw light on the general principles involved. Not infrequently this phenomenon is observed: a patient with a chronic or recurrent physical ailment, but free from psychic distress, presents himself at a medical or surgical clinic for treatment for his affliction. Successful removal of that affliction is then promptly followed by acute mental illness. A patient of mine recently had an operation for a duodenal ulcer of ten years' standing, which had given constant pain, not serious enough to prevent his success in a business career. Promptly after the operation he developed a melancholia which has now persisted two years with complete incapacitation. In these cases the removal of the pain, the punishment and the attrition, results in the appearance of a previously restrained flood of self-attacks of another sort. This is the precise reverse of the phenomenon of amelioration of mental disease by infectious somatic disease.

The implications of these data as to the essential nature of schizophrenia, and particularly as to its reversibility, are mentioned. Apparently, the plurality of reported cases presented schizophrenic pictures, but even if only one did so, and clearly, the contention that the schizophrenic process is a reversible one would receive valuable support. The theory of catalytic action proposed bears especially on this problem. All of the pragmatic consequences depend on it. What are the real conditions of reversible action in schizophrenia? To date we know none of them.

DISCUSSION

DR. SMITH ELY JELLIFFE: I feel ill at ease in attempting to discuss Dr. Menninger's paper, ill at ease chiefly because to attempt to deal with abstractions with further abstractions gets us deeper and deeper into the quagmire of further abstractions until one feels as though they are almost as far away from a concrete situation as we know certain of the nebular phenomena are, which are spoken of as being 850,000 light years situated from the earth. One does not wish to get away from concrete realities as far as 850,000 light years in the effort to pin situations down, because although Dr. Menninger forestalled me in any criticism I might make on the early part of his paper by saying "we are going to be engaged in abstractions," still the situation is of an enormous amount of theoretical and practical interest. One knows that time and time again something happens to what one may call a psychosis, and the patient recovers. One knows that in the literature of psychiatry this is frequently reported, and one does not know why these patients get well. Naturally one first starts on a query of this kind by saying, What is a disease anyway? Can one define disease in anything like a satisfactory fashion? Does it help to say in the modern language of energetics that a disease is a conflict between energy systems? An infectious disease like influenza, like typhoid, like diphtheria, is a conflict between an energy system which one calls a bacterium, with its complex and elaborate mechanism of chemical properties, and the energy system one calls the human body. The conflict between these two energy systems is what one calls a disease. Then one asks oneself in another frame of reference, What may be a psychosis, or what is a neurosis? May one define a psychosis or a neurosis in terms of a conflict between certain mental systems called the ego, the superego and the id, as Freud has suggested? When the individual must modify the environment and change it in order to get along with the expression of his instinctual needs, his id: this is a psychosis. In the same terminology, a neurosis is defined as a conflict between the ego and the instinctual needs of the id, whereby the instinctual need has to be pushed down, repressed, and it gets out by some displaced manifestations called a neurosis. The individual is in harmony with his environment, but at loggerheads with his body. Dr. Menninger has brought up the question that psychoses may be influenced favorably by influenza. As he said, chance comes in, and sometimes some systematic observations have been made whereby under the influence of an acute infectious disease, and he is speaking of influenza, an amelioration has taken place. The abstraction is that there is such a thing as influenza. We ask ourselves, many of us who are particularly interested in it, what is influenza? It is apparently at

the present time a group of things. There are some that maintain, and with a certain amount of justification, that influenza, an infection precipitating an encephalitic attack, cannot be separated from what might be called encephalitis epidemica of von Economo. For many years, influenza was held responsible for poliomyelitis, and there are a number of well sustained observations of a few writers to bear this out. I might amplify the situation so that we come back to the original problem, that influenza itself is a large bundle of possibilities, with a whole group of rather dynamic, probably polymorphous energy systems contained within it.

I am interested in the type of problem so ably presented by Dr. Menninger, and should like to hear some one present concrete, detailed studies of one particular case. That, it seems to me, is where the whole business is tending, where in terms of a complete analysis from every point of view — psychologic, somatic, chemical and what not — one may be able to get closer and closer to this problem. There is nothing more tragic for those who are interested in psychiatry than to see the asylums filled with chronic material, and it is comprehensible to understand why it is, in the effort to try to do something to this chronic material clogging up the institutions, that so many different efforts have been made. One knows that the malaria therapy for paresis started after Wagner von Jauregg, originally stimulated by the type of observations Dr. Menninger called attention to, commenced to try all kinds of toxins on various types of psychoses. Mlle. Pascal, in the hospitals of Paris, for a number of years has been attempting a whole group of protein-shock reactions in chronic psychotic patients, dealing with them as a mass, calling them "chronic psychotics." Without psychologic observations of the situations which exist, one does not get to a definite understanding of the process. That perhaps will come later, when the opportunities for close psychologic observation of the patient will enable one to arrange them into those who are more or less sick in a grouped series by some form of criteria which can come through a psychoanalytic study. Every time I look over all these things, it seems to me that the best light comes from the psychoanalytic point of view, and that starting from the top down one may arrive at some interpretative understanding of what is going on. Starting from the bottom up one is hopelessly lost. Matthews, a professor of biologic chemistry in the University of Cincinnati, once said that none of the problems of medicine will ever be solved until one knows more of the psychology of nitrogen, of oxygen and of sulphur, and to a certain extent I think he is right. How in the world is one going to know much about the psychology of nitrogen? Some of you may recall a little quotation which I do not remember overwell that I gave here from Whitehead's "Science and the Modern World," in which he said that even the electron follows the pattern of the mental states, and that is what Matthews means by the psychology of nitrogen. The nitrogen in TNT, outside, behaves as TNT behaves, but the nitrogen of the body behaves in accordance with the purpose of the body. Thus the psychology of nitrogen in the body is in accord with the mental states, the purpose of the individual, and if one knows something about the purposes of the individual, it is possible one may get some idea of what is taking place in the electrons, in the humors, in the acidoses and alkaloses, and gain an understanding of all of these, from the inside of the personality (somatic) to the periphery. So much for the speculations and abstractions of my own.

DR. A. A. BRILL: I always like to listen to Dr. Jelliffe, as he does not usually indulge in abstractions. Dr. Jelliffe began by accusing our distinguished fellow member, Dr. Menninger, of indulging in abstractions, and then he ended by questioning the existence of influenza as a morbid entity. I cannot go into any theoretical discussions. I am a clinician by nature, and when Dr. Menninger read his paper I naturally thought of cases in my own experience in which amelioration and recovery occurred. The first case of this kind, I saw after I had been in the Central Islip State Hospital a year. A patient with chronic paranoia suddenly showed symptoms of appendicitis. He was operated on and I was the anesthetist. Notwithstanding this, he made a good recovery. Mentally, he was very paranoid, with some catatonic features. He was particularly dis-

agreeable to the physicians whom he always greeted with unprintable utterances. To my amazement, he behaved perfectly during the preparation for the operation and throughout his illness. I considered him well mentally, and I was firmly convinced that either his appendicitis or the operation or both cured his dementia praecox state. As I had no similar experiences at the time, and knew nothing of the freudian mechanisms, I explained his recovery on the basis of the self-preservation instinct. My speculations were cut short when a few days after he was returned to the ward he greeted me in the same obnoxious manner as he was wont to do before his illness. He still had paranoid dementia praecox — a terrible disappointment. Then I recall a patient with catatonic dementia praecox whom I had to feed by tube for about four years. He looked as yellow as wax, and was emaciated and weak so that I expected him to die every day, but all of a sudden he wanted to know when he could go home. He seemed perfectly well. I brought him before the staff and it was agreed that he could go home. It took the relatives about two months before they decided to come for him, and when they finally called for him he refused to leave the hospital. Subsequent examinations showed a distinct mental and emotional deterioration, although the patient maintained himself socially for many months. Since then I have seen a number of so-called recoveries, especially after acute diseases and attempted suicides. None of the patients remained well for any length of time, unless the psychoses were of the benign manic or infectious types. I have never seen a single patient with, let us say, dementia praecox, recover suddenly following an operation or infection. I say dementia praecox because one knows that nearly all other forms of mental diseases do result in recoveries and ameliorations. To be sure, one has to make a more specific diagnosis. "Mental disease" means little to me — it may mean anything. I could speculate about it just as Dr. Jelliffe did with influenza. I wish to remind you that even the persons with different types of schizophrenia, and surely the manic-depressive types, all have remissions, and those with the latter usually get well regardless of what one does or does not do. Years ago, I saw a schizoid manic patient who was sick for three years, and then attempted suicide by hanging. He soon thereafter got well and was discharged. Two years later, he had another attack from which he has not yet recovered. There is no such thing as a cure once a malignant form of mental disturbance establishes itself. There may be good social adjustments which can be brought about by slow training. Dr. Menninger was wise to use the term "ameliorating," which is a fluid sort of term. Its meaning depends on the person who uses it. Let us not forget that from time to time "cures" and ameliorations have been claimed through various means such as the removal of focal infections, operation etc., all of which may seem true in some benign cases but, once a person is schizophrenic he remains schizophrenic.

Dr. Joseph Smith: After hearing Dr. Menninger's paper and Dr. Jelliffe's discussion, I was glad to hear Dr. Brill get down to practical matters; after all, one should discuss this paper from the standpoint of personal experience. During the time of the outbreak of the first epidemic of influenza, I saw numerous cases in the Brooklyn State Hospital, but I do not recall a single instance in which a patient has been permanently benefited by this intercurrent disease. Dr. Brill is right in making a distinction between a cure which occurs in a manic-depressive psychosis, and which may be expected, and a supposed cure in a case of schizophrenia. I take it for granted that Dr. Menninger did not intend to convey the impression that there is some specific virtue in the toxin of influenza; rather, that the toxins of any infectious disease — typhoid, pneumonia, etc. — may favorably affect a psychosis. This is probably the basis of the malarial therapy in paresis, and it may also be assumed that an amelioration of a functional disorder may be brought about in the same way. However, those of us who have observed cases of dementia praecox have failed to note a permanent improvement or cure following an infectious disease. These patients often react favorably to changes in the environment; thus, an unexpected visit may influence them pleasantly. A similar explanation holds good in those cases in which a serious intercurrent disease

threatening the life of the patient will bring about a change in the ideational content and alter the direction of his strivings.

DR. M. S. REUBEN (by invitation): I do not feel qualified to discuss neuroses and psychoses, but I was interested in what Dr. Menninger said about a mentally defective child who was benefited mentally following an attack of influenza. It is a rather astonishing statement to hear from a neurologist. I have been interested in mental deficiency for many years and have seen many brains of defective children, and I have yet to see the brain of a mentally defective child that did not have some anatomic defects — sclerosis, porencephalus, aplasia, etc. How influenza can influence any anatomic defect is hard to understand. More than once I have made a diagnosis of mental deficiency and the subsequent course proved my diagnosis incorrect.

We had a child at the hospital who was not progressing favorably; the house physician was anxious to try a vaccine. Although I was opposed to it, I allowed him to try it, as no harm could result from its use. After the first injection there was some improvement and after the second there was marked improvement. On questioning the nurse, we found that the vaccine had been administered by mistake to the child in the next bed. In drawing medical conclusions one must allow for extraneous factors and coincidence.

DR. D'HOLLANDER, Louvain (by invitation): Like all of you, I have been impressed by recoveries in some cases of psychoses as the result of an intercurrent disease; such recoveries have been reported by psychiatrists of early times. In his "Traité de phrénopathies," my countryman, Guislain, of Gard, has reported examples. The seton, the "moxa," the pustule are measures that have been employed for this purpose.

Led by the fortunate results obtained by infection with malaria in paresis, we have, at the Psychiatric Institute of the University of Louvain, experimented with relapsing fever. This method was chosen for the following reason: usually, the spirillum of relapsing fever must be obtained from mice, infected preferably by ticks; my colleague, Professor Bruynoghe, has succeeded in preserving the spirillum in pure culture; in this way, we have been able to infect rapidly a large number of patients — fully twenty cases of early dementia praecox, mania and melancholia. I regret to report that this method of infection has been without curative result. Without doubt, one should differentiate, in the treatment of the psychoses, between spontaneous infections and those which are caused experimentally. An account of these experiments appeared in the *Journal Belge de Neurologie et de Psychiatrie.*

DR. MENNINGER: I shall take up the discussion in the reverse order. I am not so impressed as I should be by the remarks of Dr. Reuben, because to say "I cannot see how something happens" neither supports the validity of the observation, nor entirely destroys it. The facts were: the child discussed was an idiot, had influenza, and ceased to be an idiot; that is all that I have claimed. My article details another case in which evidences of organic disease were obvious; this child deteriorated to a state of what was described in the literature as complete idiocy at the age of 10; then he had two attacks of influenza; at the age of 12, this child was actually ahead of his brothers and sister in school, and was considered to have recovered completely from the idiocy. I did not cite that case, not because I did not believe it, because I have no particular reason to question the veracity of those who contribute cases to the literature, but out of consideration for the next speaker; Dr. Dearborn should realize that I have been accused of having been too abstract merely because I wished to give him more time for his paper, and failed to read the case histories I have in mine.

Dr. Smith indicated that he was glad to hear Dr. Brill say something sensible and concrete after the discussion by Dr. Jelliffe and myself; I wish to state that the case histories with all details will be printed, so that they can be scrutinized. I must confess that I myself have had the same sort of misgivings, and that is why I began to look into the question. I was surprised at what I uncovered.

An interesting thing has lately been found by Kubitschek, in Philadelphia; he tried some intraspinous injections and after some carefully controlled work felt

sure that the amelioration which occurred, and which was always temporary, was dependent on psychodynamic factors; a temporary improvement, however, did occur, and in some instances it has been a permanent improvement.

The theories involved offer room for differences of opinion. Dr. Brill and Dr. Jelliffe discussed them, and I was anxious to have some criticism of the various propositions. I should like to have known what other explanations can be postulated. In regard to Dr. Brill's position about recovery from schizophrenia, I believe that it begs the question; I assume that some of these cases were schizophrenia, but I do not know that they were. They looked like it — they were certainly schizophrenic. I do not know that it makes so much difference whether one calls the condition schizophrenia. Some of us are a little out of patience with the making of diagnoses; it seems sometimes that making a diagnosis is continuing the illusion of pasting a name on something to inform the patient that we know something about him. It may seem more important to know what kind of failure a person makes when he has to face a situation. One gets nowhere by calling names. I believe that we shall make progress faster when we recognize that certain persons have personality disorders of a type that makes them impossible, and some persons of this type have a break-down which we call schizophrenia, whatever that may mean.

I think that Dr. Jelliffe's objection is philosophically a good one, but whatever happens to these persons, happens to them, and they change to an adaptation which everybody wishes they had had before. Why did it happen? I do not know.

Two Hundred and Fifty Delusional Cartoons by a Patient with Dementia Praecox. Dr. George van Ness Dearborn.

The contribution consisted chiefly in an exhibition of about 150 cartoons, large and small, in pencil, ink and water colors. These were examined before the meeting by many of those present. Dr. Dearborn presented notes as to the conditions under which the cartoons were produced, and gave a brief family, personal, industrial and medical history of the case. Lantern slides of typical cartoons in pencil were then shown.

Discussion

Dr. A. A. Brill: I know this patient. I saw him when he first came to the hospital and again last week, and I certainly agree with the diagnosis of paranoid dementia praecox. As regards these pictures, one must remember that the patient was always artistic; his history shows that he was told he had talent for drawing. In other words, do not imagine that it was the dementia praecox state that brought out this artistic talent. The material displayed here would be of great interest, as I told Dr. Dearborn when he showed me these productions, if one knew something about its meaning. That is, if an attempt had been made to correlate these productions with the patient's psychosexual development and behavior in general. Dr. Dearborn's reference to them as "hodge-podge" is very sad indeed. I do not think that there is any hodge-podge to it. Everything shown here must have a definite meaning to the patient which, if interpreted, would throw much light on his psychosis. From my own observations, I believe that by virtue of his artistic talent the patient represented pictorially his delusional struggles. I could interpret each and every one of these pictures as referring to his abnormal effort at adjustment, but as I have seen so little of the patient I can make only general remarks. One should be fully acquainted with the patient's deeper mechanisms; otherwise, there is not much value to these pictures. That the insane often express their struggles through drawing, painting and sculpture is well known to all who have lived in hospitals for the insane. Such productions are of special interest when they are done by persons who never displayed any artistic talent or artistic interest before they became psychotic. I have a collection of poems from a former grocer, and I shall presently show some tapestries made by a paranoic patient who was formerly an unskilled laborer. We all know that artistic productions of the insane are now used as an aid to diagnosis and a great deal has been written about such insane art. Lombroso used such pictures for

diagnosis, particularly in epilepsy, and Morgenthaler, Prinzhorn and others devoted much study to this subject. Prinzhorn has given a fascinating work on abnormal artistic productions. The interesting collection in Heidelberg is well known to many of you. It is significant to note that 75 per cent of the productions in the Heidelberg collection were made by schizophrenic patients. My own interest in this subject began in the hospital. I have been collecting such artistic material since, and in order to illustrate what one can see in such crude art, even without resorting to freudian mechanisms, I shall tell you briefly about a patient in the Central Islip State Hospital. He was an Alsatian and was admitted to the hospital in 1895. I met him in 1903, when he showed a clear picture of paranoia. He was the "second redeemer of the world." From what I gathered, he went through the usual acute state, lasting many years, which was characterized by many hallucinations and delusions. He was a farmer by occupation, but just before his internment he worked as second man in a hotel kitchen. For years he never kept a job for more than a few weeks, generally not more than a few days. He had the delusions which one commonly found in those days and which are rare now. The Devil, in the form of Lucifer, and the Angel Gabriel were talking to him, one in each ear. They made him do all sorts of bizarre things, so that he was finally arrested and sent to the hospital. When I met him he occupied all his leisure time in making such tapestries as these shown to you. He would pick up discarded old shirts and save what linen was left, wash it, and then use it as a background for his embroideries. The colored threads he obtained by unravelling old quilts. With the heart and soul of a paranoiac, he gave infinite patience to the selection, assorting and cleansing these threads. A needle completed his armamentarium. His first name being Joseph, he called himself Joseph the Carpenter, or King Herodias. The first tapestry is almost an exact reproduction of the group of buildings in which he lived before he was admitted. The resemblance and the detail are really remarkable. The second depicts a prophecy he made in 1906, that there would be a tunnel under the Hudson River, and the third shows himself and his wife as the central figures in the middle and all around is his conception of the world system, finely embroidered. You will note that his wife, the queen, looks like the crude madonna type of medieval days. Throughout his acute stage he was forever tempted by women at the instigation of Lucifer, and he ran from place to place in order to escape these temptations. The history and his artistic expressions represent his life struggles, especially in the psychosexual spheres, which he finally realized by his abnormal adjustment to the hospital. He was really the king, Herodias, and we doctors were his official servants. Dr. West, whom you can all see on the right, was prime minister, and I am represented as secretary of state. Showing us in gaudy uniforms as you see is no crazy imagination. The whole staff was attired in a sort of hybrid army-navy manner. In other words, the artistic productions represent the patient's whole life, especially his psychosexual conflicts. That there is some artistic merit in these tapestries is attested by the fact that when I showed them a few years ago in an art gallery, some of the most famous modern artists adjudged them as excellent examples of Byzantine art. Speaking as a freudian, which I was not when I studied this patient, I would say that having been fixed in his narcissistic state, the patient could not adjust himself to heterosexuality; as shown by his history, he continually ran away from it and finally succeeded in desexualizing his libido and turned it into mysticism, becoming a second redeemer, a king. I am convinced that Dr. Dearborn would have found similar mechanisms in his patient. To be sure, this case is still in an acute state, and as the patient was always artistically talented, we have profuse productions which, to the uninterested, seem "hodge-podge." Still, from what Dr. Dearborn told us, this patient corroborates all the freudian theories of homosexuality and paranoia. For one knows that in both cases one is dealing with narcissistic situations. The patient was frankly homosexual, which means that he identified himself with his mother instead of his father, and being unable to take his mother as a sexual object when he reached the genital stage of puberty by virtue of the incest barriers, he selected another object on a narcissistic basis

to occupy his own ego, on which he lavished all the affection which his mother lavished on him. He then loved young men homosexually and as long as he was homosexual he was not sick. For some reasons unknown to me, he merged into conflicts and finally gave up homosexuality by desexualizing his libido and repressing his homosexual cravings. He then became a paranoiac, for, according to Freud, the delusion of persecution results from repressed homosexual wish fantasies. The direct determinants or the meaning of his productions could easily be discovered by analysis. The few interpretations given by Dr. Dearborn about the freudian part — I refer to the picture which Dr. Dearborn claims represents the patient's family, who were killed by the freudian effluvia — need not be taken as any effort of real interpretation. For the figures in this picture look far from dead, and Dr. Dearborn does not tell us why the patient labeled this picture "Holy Night."

Dr. Hiland L. Flowers (by invitation): I feel somewhat like the student who was brought up for examination and asked to give a criticism of Caesar's invasion of England; he knew all about Caesar, but very little about his invasion of England, and he said "Far be it from me to criticize immortal Caesar!" After Dr. Brill's discussion I do not think I can add much. This case is interesting. It is one of the few cases one can see developing from an apparently normal but peculiar into a frankly psychotic person. The point was brought out that while he was frankly homosexual he was not psychotic. He managed to get along for many years as a frankly homosexual individual, and enjoyed it. He was well known, and made some money at it. They called him "Midnight" so as to get hold of him, and some of these terms that are used like the "freudian catholics" have a distinct meaning to this patient. He was working in Chicago, acting as nurse in a catholic hospital, and many of his homosexual friends were catholics; at that time he was employed by G. T.; you may have seen his name in the paper; he is the son of a rich man, and is rich in his own name. G. T. was being treated by a psychoanalyst, so this patient was exposed to psychoanalysis; he heard Dr. Neymann talking to him, and heard various comments made as to what homosexuality was, and from that he developed some insight into his own condition. Naturally, it turned him against freudian theories because it made his own situation painful. One can understand why catholics are painful to him when I tell you that the man who displaced him with his mistress had the name of McCarthy. It is not difficult to understand that all Irish and all catholics partook of the disagrecableness that this man had for the patient. It was at the time that his mistress turned him down that he began to think that McCarthy was talking behind his back, and that other people were talking behind his back, especially that a man named Monk was talking behind his back, and he soon began to feel that there was a conspiracy against him; this feeling spread, and within a few months it became so great that it involved the whole world. This case shows clearly how a person can develop a psychosis when a painful situation is brought to him. While he had no reason to fight against homosexuality there was no psychosis, but as soon as there was a reason to fight he developed the psychosis. He had some moral training in his youth; as soon as he began to fight he had a conflict, and soon he developed the psychosis.

Dr. Dearborn has said that these pictures are a hodge-podge; I agree with Dr. Brill that they are not. This patient considers himself a supernatural being who is endowed with rights whereby he can interpret hallucinations; he has a distinct mission in life, and that is to counteract the effect of the freudians and the catholics. You see these pictures, in which he is portrayed as a prophet; in most of them he is giving to the world his ideas that freudianism, catholicism, etc., are harming the world. Naturally, the reason why he fights these things is that I have already mentioned. Throughout the pictures that motif runs underneath. It is true that in detail each picture is somewhat different. Occasionally he will attack Al. Smith, because he was in the foreground of the news at the time. The 10 gallon hat was also in the papers, and naturally he made pictures about that, but in general the underlying theme is that he is a persecuted individual,

being persecuted by a conspiracy of freudians and catholics, and that he represents a prophet; it is his mission to give that idea to the world.

DR. SMITH ELY JELLIFFE: Dr. Dearborn and I have been friends for many, many years. We used to play on the beach together, and discuss problems in academic psychology, and I know he will forgive me if I say he is still playing on the beach with academic psychology when he says that what he does not understand is "hodge-podge." Those of us who do not understand Chinese think that it is "hodge-podge." Any man who says the material in these pictures is "hodge-podge" does so simply because he does not understand it. Dr. Dearborn said he tried to arrange these things in types. He stated that he could find no types. If one does not know any botany and goes out on the hillside and collects a lot of plants, he does not know how to arrange them, because he lacks systematic ideas of the classification of plants. If he has some idea of their types, he can arrange them into their natural orders and groups, and the insight that he has enables him to arrange his observations in an orderly manner. As I sat here, I whispered to Dr. Brill, apropos of one of these interesting pictures. I was able to tell Dr. Brill the history of that patient before Dr. Dearborn had said a word about it. I said he had active homosexual ideas, and he has so many brothers and sisters. The incest motif and everything else that Dr. Dearborn later told us are in that picture. One does not need 250 pictures to show the more obvious features because each picture is over-determined. That means that a single picture is like a series of lithograph impressions, one printed over the other. Thus one can find the whole story in one picture. One has to have the patient, however, really to analyze a picture thoroughly.

What sort of a unifying conception does not have to begin with such an interpretative process? One knows well that many things that Dr. Dearborn said point to the Oedipus situation. Hence, use this concept like an X in an algebraic equation. If this is done the part about the catholics and about Smith become clear. There is also the blind mother, the incestuous mother, with that long arm, with the word Cain upside down on it. Who is Cain? Cain is the man who killed his brother. What is behind homosexuality? It is the unconscious tendency to kill the male (i.e., put him away), in order to reach the female. Thus, in our interpretative methods, one could go over the colors, the looks of the eyes, and the direction of the eyes, all pointing to the left, looking down, where Satan is on the wrong side, instead of looking up and to the right. There is not a single picture in which there is anything which one might call ecstasy or love. All picture destruction and sadism, all the way through. One could talk hours about a single picture, the colors and the shapes and the forms. It is not Choctaw to anybody who will try to understand the language. I would make one acid comment. We have heard about the "effluvia" of freudism. I mordant my acid comment. May I say that the people who make such kinds of remarks (I am not referring to Dr. Dearborn) who may consider themselves normal may have as much dementia praecox tucked away in their skins as has this patient?

DR. LOUIS S. ARONSON: At the Salpêtrière, in Paris, they have a little laboratory of Charcot's with his desk and all his things intact, including his drawings. Charcot was a good artist and a good sketcher. He stimulated Richet to do some work on hysteria which is considered very good. This little drawing that I was shown was 10 by 14 inches, in a frame, and when my French friend showed it to me, he held his thumb over the label, and asked "what does it look like?" It was a pencil sketch of what has been alluded to this evening so much as "hodge-podge"; a small section of a town, with many steeples and towers and a celestial overhead, and a deep foreground in which a man was asleep; from his body there came smoke or effluvia, and the whole thing was all mixed up. I said "It looks like a delirium," and he replied "You are right; it was drawn by Charcot himself during an experimental hour with the use of hashish, or cannabis indica." I mention this because I should like to be informed whether the man had a real artistic background before, or whether it was stimulated by his delu-

sional states, and secondarily, whether he did most of these drawings in an exalted state, or when he was depressed.

DR. DEARBORN: I wish merely to say that the word "hodge-podge" has two meanings; one of them is that it is a miscellaneous and very various accumulation, but without any disparaging or derogatory connotation whatever. Certainly I had no idea of belittling the subconscious value of this material.

I may say frankly, in answer to my friend Dr. Jelliffe, that my chief objection to freudianism is this: It always has appeared to me that nearly everything the freudians describe occurs in certain persons; where I differ with them is in their claim that these things are universal in the human mind. I am sure that everything that the freudians have described can be found, but I must say I am far from convinced that they are in the subconscious of every one. I repeat for emphasis, because to my mind this is close to the crux of the whole controversy.

PHILADELPHIA PSYCHIATRIC SOCIETY

Regular Meeting, March 8, 1929

EVERETT S. BARR, M.D., *President, in the Chair*

THE EUGENIC MOVEMENT. DR. GERALD H. J. PEARSON.

The idea of eugenics did not originate recently but has existed from the earliest history of mankind. Perhaps always, thoughtful human beings, beset by a sense of their inability to make the most of their lives — an inability which they attribute to the incompetence of their fellows — have tried to devise some plan to increase the capabilities of these fellow men. Whatever the reasons alleged — better man power, greater physical beauty, higher intelligence, social position or improvement of the species — or the methods used — infanticide, caste systems, regulation of marriage (endogamy or exogamy) birth control — the underlying purpose seems to be a wish to free future generations, and particularly one's own children, from the hindrances which seem to have frustrated one's own ambitions. This is a laudable desire, provided that its roots are recognized and that its expression does not provide for the individual a means of escape from the necessity of making his own adjustment to the world as it is. Every race and every age has employed its own methods for race betterment, generally in an empiric fashion without any understanding or formulation of the factors involved. The first real attempt at such a formulation was made by Galton, who may be regarded as the father of the modern eugenic movement. As early as 1876, he advocated the study of methods for the improvement of the race, but not until 1884 did he announce his concepts, to which he applied the title of eugenics. He defined eugenics as a study of the agencies under social control that improve or impair the physical and mental qualities of future generations. He grouped these influences into two classes: hereditary and environmental. Galton considered the influence of heredity paramount, for he, as well as the rest of the scientific world of his time, was deeply interested in the theories of evolution propounded by Spencer (1864) and Darwin (1868). The stress he laid on heredity is evident, in 1904, in his revised definition of eugenics as the science that deals with all influences that improve the inborn qualities of the race and that develop them to the best advantage. He thought that the improvement of the race would depend on the dissemination of knowledge of the laws of heredity and the application of these laws. Although Galton's theory of heredity is now of historic interest only, laws of heredity as applied to human beings are still unknown, and Mercier's reply to Galton's address is as true today as it was in 1904. He said "the speaker has placed great value on the dissemination of the laws of heredity in so far as we know them — which is not at all in regard to human beings." It would seem that studies on heredity have attempted to compare two uncomparable things. Through careful selection

and inbreeding, animal experimentation has shown the validity of the revised mendelian laws in regard to the inheritance of physical traits; but can such results be applied to mankind, who, because of the taboos against inbreeding, can never be other than a race of mongrels? Theoretically, it would be possible to develop a race of people with one or two outstanding physical characteristics or skills — a race of longshoremen, for example — but would such a specialized improvement tend to improve the race? No one can deny that heredity plays an important rôle in determining the physical constitution. This concept, however, seems to have inhibited the thinking of many eugenicists. Does the possession of a perfect physical make-up mean necessarily an improved race? If this were true, then the eugenic world would be poorer by Calvin, Newton, Hume, Voltaire, Stevenson and Steinmetz, whose attainments may have been a compensation for their physical disabilities, as Adler pointed out. Although heredity does influence the physical constitution, is it as responsible for psychic characteristic and behavior?

The contrast between the families of the Jukes and the Edwards has been cited frequently as indicating that it is, but it must be remembered that Jonathan Edwards' grandmother, Elizabeth Tuttle, is described as a woman of great beauty, a tall and commanding appearance, a strong will, extreme intellectual vigor, a mental grasp amounting to rapacity and an extraordinary lack of moral sense. One of her sisters murdered her own son, and a brother murdered another sister (Newman: Evolution Genetics and Eugenics). And Jonathan Edwards had the physical characteristics of his grandmother. The more one studies behavior problems the oftener one sees the same forms of behavior repeated generation after generation. The problem is repeated, but so is the parental attitude to the child. A child reacts to the parent's attitude in a certain way. When he in turn becomes a parent he acts to his child as he reacted to his own parent. This might seem like an inherited pattern, but when it is remembered that a young child forms his ideas of how adults should act by observation and imitation of his parents, it seems not unreasonable to conclude that he follows this imitated pattern in his own life as a parent because it has come to mean to him the ideal way in which a parent should behave.

Galton did not believe in hereditary influences to the exclusion of all others. He also stressed the importance of environment. His disciples, as is the fashion of disciples, went much further than he did. They developed a eugenic fatalism — a blind faith in the omnipotence of heredity, regardless of the surroundings in which the individual was placed. Davenport went so far as to state that eugenics has reference only to the offspring; that the success of a marriage from the eugenic standpoint is measured by the number of disease-resistant, cultivatable offspring that come from it and that the happiness or unhappiness of the parents has little eugenic influence. This is an extreme view and is not in accord with the facts except as regards the physical health. There seems more and more evidence that behavior is an attempt on the part of an individual to obtain happiness — that is, that it is purposive and is his attempt to adapt himself to his environment. One of the difficulties in accepting this point of view lies in a lack of understanding of what constitutes the environment. Freud has made notable contributions on this point. The environment not only is the physical surroundings, but consists largely in the emotional relationships between the child and his parents, which relationships are the outgrowth of the relationships between the parents. Out of this triangular emotional setting the child develops his ability or inability to fit into the life of the world. It seems probable that these relationships exert their greatest influence during the formative period, the first few years of life. When one considers the large number of intensive studies that have been made on the personality and behavior of late childhood and adulthood and on the influence of heredity on the formation of the personality, it seems amazing how little attention has been paid to that most important period of life, the preschool period. As long as this period remains a terra incognita it is impossible to make any formation of the relative importance of heredity and environment. The aim of the eugenicists has been to improve the race, a worthy aim, but, influenced entirely

by their theory of the paramount importance of heredity, they have advanced no method of doing this except that of preventing reproduction by those whom they consider racially unfit. (It is interesting in this connection that the first International Conference on Eugenics was held as recently as 1912; the most recent one, held a few years ago, was designated an International Conference on Birth Control.) They have postulated no standard of racial fitness or unfitness; in fact, the relative fitness or unfitness of the forms of human behavior depends on the point of view of the eugenicist. One could visualize a eugenic world in which an infraction of the Volstead Act would unfit an individual for reproducing his species. The question of standards is important. A physically perfect individual may be unfit totally in other ways. Another person, like so many famous artists, may be brilliant intellectually — a genius in the eyes of the world — but an unhappy and maladjusted person. A successful man may not be a desirable citizen. No one of these types can be considered a standard for the improvement of the race. Every person seems to be striving for personal happiness, and it is possible that happiness for the individual, separately and collectively, may be the true standard for racial betterment. Perhaps the eugenic movement, in planning for the future, has forgotten the present, and the future of the movement may need to consist not only in collecting biologic and sociologic data, but also in attempting to understand better the living individual, his potentialities, deficiencies, needs and satisfactions, and to help him to a more adult type of adjustment to himself and to the world in which he lives for the improvement of the race. The methods suggested by the eugenic movement have been largely coercive, and therefore not practical. The emotionally mature person will accept and apply whatever contributions of biology, physiology, psychology and public health are of value. Thus, by developing the individual, the aim of the eugenic movement may be accomplished more surely and more speedily than by the application of drastic coercive measures.

EUGENICS FROM THE PEDIATRIC STANDPOINT. DR. EDWARD L. BAUER.

While philosophers cogitate fruitlessly the destiny of the human race, certain cultists plan the development of a "super-race," and are devising ways and means for the attainment of this nebulous ideal. Early in philosophic thought, the spiritual and corporeal division was made, and religious development had worked out several more or less satisfactory dispositions for the soul. Spiritual leaders have not left the body entirely out of consideration, but it is of such minor importance in their calculations that they offer nothing of value concerning it. The cultist does attempt to give his theories color in his effort to direct human destiny to a physical and racial perfection. He has christened his cult "eugenics," and has defined it as a "science of improving offspring by restricting marriage to healthy people who will produce healthy children." An ambitious program is involved in this definition. First, the eugenist must develop some real basis for pronouncing the love birds healthy; then he must establish that the offspring will be healthy, and finally he must develop a science that will make all this a practical reality.

The solution of the problem of healthy parents has been approached through three channels: (1) the establishment of mental standards; (2) the establishment of physical standards, and (3) a combination of these two.

To accomplish the first, a literacy test seems sufficient to the eugenist. So far as the second is concerned, much rambling discussion concerning giants, dwarfs, brunettes, blondes and albino rats seems to represent the extent of the scientific lore he offers. As to the third, he jousts with the first and second and finally announces his triumph in this ringing conclusion, "a healthy mind in a healthy body." Then he sweeps the whole subject into one aphorism, "the nation is made at the marriage alter."

Much has been said about the desirability of sound minds in sound bodies. With this theory I am sympathetic. Until one knows definitely, however, just what is meant by each, and agrees on the maximum and minimum range limits, basing one's decisions on some logical reason for assuming these limits, one is

not in a position to be dictatorial about the application of rules and regulations governing marriage.

The division of the race according to a literacy standard would accomplish nothing but the establishment of a rigid caste system with as many rogues in the controlling class as out of it. The eugenist himself states that "mental testing 'underdeveloped' makes the world safe for stupidity." From reading his text further I gather the impression that "developed" in this sense would mean sterilization for those who do not make the mental grade. It is further asserted that by means of sterilization, insanity and idiocy would be made to disappear from the face of the earth in four generations. It is agreed that the insane should not marry. The mental deficient who is incapable of earning a living should also be celibate. But even if one bars from parenthood all who do not achieve a passing grade in the mental gymnastics of psychometry, one will not eradicate mental deficiency. I offer as concrete proof the case of the mongolian idiot who does not reproduce. When the light of research is turned on him and his progenitors, none of the theories of heredity, environment, disease and so forth will withstand its piercing ray.

There is no reason to believe that the mental laggard prevents the mental advancement of his more liberally endowed brother. Since no attempts have been made to eliminate the mentally unfit, and since those of keener minds have always been generally less prolific, why has not racial decadence already become an actuality? Instead, a steady, slow evolution toward betterment has occurred. Many of the mental giants came from stock that in this day would be stamped as mentally mediocre by cultist guardians of the marriage altar.

Physical perfection is the subject for further discourse by such theorists, and much pessimism is expressed concerning the modern manner of achieving it. One writer, for example, is sure that maternity is being made too easy, with the inevitable result that women will soon be unable to bear children naturally. He seems to think that fewer cesarean sections should be performed, and perhaps has in mind the calibrating of all female pelvises as a prerequisite to the marriage license. The Spartan is held up as the shining example of how strong a race can become by eliminating its weaklings. I am impressed with this most particularly when I see their descendants twirling huge trays of dishes in restaurants or cleaning hats and shoes with abandon.

The pediatrician, the medical specialist who devotes his time to the prevention and cure of disease in infancy and childhood, is also assailed by this cultist, not by name, but because of his work. For some unknown reason the infant that waxes strong on cow's milk instead of on the lacteal product of his mother is regarded by him as a physical pervert of some kind or other and a menace to posterity. Decreasing the incidence of microbial diseases also elicits a protest, because it lowers, he holds, a resistance both to disease in general and to the particular illness which is being or has been eliminated. In answer to this, diphtheria prevention can be cited as a direct contradiction, for while diphtheria is prevented in the individual, it is done only by stimulating his own latent or potential power of resistance.

The falling incidence of tuberculosis is furnishing material for a monument to pediatric hygiene. Tuberculosis is essentially a disease of childhood, as was smallpox before vaccination became general. The decrease in infant mortality, another product of pediatric sagacity, is passed over by the cultist with the statement that mortality tables show an increase in the death rate in children past the infant age. This really means nothing more than the fact that the death rate in infancy has dropped far more rapidly than has the death rate in older children. Actually, both the case death rate in contagious diseases in older children and the rate per hundred thousand are declining, but not so rapidly as in infancy. Diphtheria, for example, has decreased from 60 to 10 per cent or less in twenty-five years. Scarlet fever has a negligible mortality. The death rate from whooping cough and measles with their complications, while declining, is higher than that from either diphtheria or scarlet fever. From the mortality tables it is easy to see in which diseases the greatest strides in preventive medicine have been made. It is not easy to see, however, how failure to contract any of these diseases has handicapped any child in his physical development toward a sound, well rounded maturity.

In checking the infant mortality tables one finds that the only causes of death that do not seem to be decreasing are extreme prematurity and maldevelopment. Such causes of prematurity as can be ascribed to hereditary influence have been legislated against, but a decrease in this incidence can be ascribed only to medical treatment of the causative factors and not to a reduction in the incidence of these factors. Those that do not occur in this category or in the malformation group give no inkling as to the possibility of their occurrence in the parents or the parents' history. Any pediatrician or obstetrician of experience has had examples of monstrosities born of women who under no circumstance would have been barred by the rigid eugenics altar committee.

The pediatrician realizes that environment plays an important part in every child's life. If he is astute, he realizes also certain limitations in this element. If he is experienced, he can determine why the effect of environment is limited and frequently can turn it to advantage. This is actually applicable also to hereditary factors. Heredity is more frequently of distinctly less importance than environment, by reason of the fact that heredity is diluted in its effects in individual cases because of the multiplicity of cross currents from which the individual is derived. Even the eugenist, presuming that he has a family of sufficient importance to trace back any length of time, may find, as an eminent divine once stated, that he had in his tree a "horse thief, caught and hanged." Or he may go further and discover the bar sinister on his heraldic escutcheon. Therefore his pessimistic plaint that "torrents of degenerate and defective protoplasm are being poured into the human race" need not add to his misery.

The pediatrician realizes that there has been handed down to him by generations of races a scheme of things that has been worked out inexorably by huge numbers of causes and events, and that has resulted in a distinct advance for the human race. In the ripeness of his experience he recognizes that a certain difficult stage in human development has been reached from which still further progress will be made. He knows that he plays an important rôle in the progress of his generation. Along with the rest of his race he must make the world a healthier and happier place in which to live. He feels it his duty to alleviate human suffering as far as he knows how, discovering new truths to that end, so that he may be prepared in his infinitesimal period of work in this cosmic scheme to pass on to the next generation that little forward move and urge to move. That generation in turn will do likewise, as will the next, the next and next. This is the road to racial salvation, more promising by far than any attempt to limit the trend to a specific channel. Ajax' defiance of the lightning was a proper procedure when compared to the effort to dam the momentum of the ages of human progress, and to divert it into the fantasy of a superman. Only a divine power can know what will become of the human race, nor will he find it out from daisies or guinea-pigs. The best contribution to the future will be made by the diligent performance of one's chores as individual heredity, environment and training alone can direct.

SOME THOUGHTS ON EUGENICS. DR. JAMES HENDRIE LLOYD.

Eugenics was founded by Francis Galton, who was inspired by the theory of evolution, recently advanced by his great kinsman, Charles Darwin. Galton's idea was biologic. For him, eugenics was largely a problem in heredity and breeding. It was long held that acquired characteristics could be transmitted, but this doctrine has been combated by the followers of Weismann. Eugenics becomes a study in race betterment, and its promotors have done good service in encouraging a study of the facts of biology and, on the other hand, in exposing fads, fancies and abortive schemes of reform. Their aims are scientific, although some eugenists have doubtless indulged in utopian dreams. The paper was devoted to a brief discussion of the various subjects thus suggested, such as heredity, selective breeding, birth control, feminism, philanthropic schemes, reform of criminals and sterilization. The object was to do full justice to the work of Galton and his followers, but at the same time to show that while the eugenists recognized the various problems they had not yet gone far toward solving them.

RELATIVE IMPORTANCE OF HEREDITARY FACTORS IN CONSTITUTIONAL AND ORGANIC PSYCHOSES. DR. C. B. FARR, DR. L. L. SCHWARTZ and DR. L. H. SMITH.

Methods for classifying and evaluating hereditary factors with reference to psychoses in general were discussed. Manic-depressive psychosis and paresis were taken as types of the constitutional and organic psychoses respectively. The statistical data in the literature (Koller, Diem, Ruedin, Kalb and Suenner) were compared with the authors' own observations in 100 paretic patients (74 men and 26 women), and in an equal number of manic-depressive subjects (76 women and 24 men). Contrary to former reports, the present writers found an approximately equal incidence of strictly psychotic heredity in the two conditions (34 and 30 per cent), in either case beyond the normal average. However, while the number of "tainted" families were nearly the same in the two conditions, the number of "tainted" individuals in these same families were actually greater in manic-depressive histories (heaping-up of hereditary factors). Of the other "tainting" factors commonly noted, suicide and idiosyncratic personality were noticeably frequent in manic-depressive histories, and nervous diseases, alcoholism and apoplexy in paretic histories; senile and arteriosclerotic dementia showed no difference.

Conclusion: Paresis is not a good example of a purely organic psychosis — hereditary psychotic factors are in part determining. On the other hand, 70 per cent of the manic-depressive cases in our series showed no direct psychotic tainting; 40 per cent were altogether free from direct or remote psychotic tainting, as well as from any of the "taints" commonly regarded. Environmental factors, hence, have more importance than is usually assigned to them.

DISCUSSION

DR. BAUER: If everything Dr. Lloyd had to say about eugenics is true, I would have to apologize for all but about two minutes of my entire paper. If one is going to bring children into the world and carry them through the first year only to have them die off at the age of 15 or 18 months, that is an economic waste. However, there is a decrease not only in infant mortality, but in children in preschool groups. If the infants lived only to enter the run-about age, there should be an increase in the mortality of the run-about age. These figures were worked out with the object of proving or disproving this statement. The figures show a decrease from year to year.

A group of about 500 premature children was studied from the time of birth to the eighteenth or twentieth birthdays in the clinic of Pirquet by one of my assistants. They were followed up closely and carefully. It was found that in some instances they were, perhaps, undersized from the standpoint of the average Austrian, but they were mentally and physically on a par with their brothers in an unusual degree. The premature child is considered a biologic inferior from the standpoint of eugenics. Now in my brief years in practice and on this earth, I have already had two generations showing people distinctly athreptic in infancy whose children were healthy. One cannot believe that here duty stops when the child is born. These children are going to have children. If their heredity has been settled before my father was born or my grandfather — then my children's heredity was settled without my influence and this evening has been a waste. What right has any man to say to me — for I was a lowered-resistance baby — that I should be sterilized and not have children? My children are normal physically and mentally and are keeping up with their classmates. Should I have been sterilized? What right has any man to rob one of the only tangible evidence of eternal life? So far as heredity is concerned, it is more impressive to the psychiatrist and the psychologist than the pediatrician as is evidenced in some of these figures such as Dr. Farr presented.

In my association with children I am sure there are influences other than heredity. For example, I studied a pair of Greek twins. When they were born, one weighed 7 pounds 8 ounces (3.4 Kg.), the other 7 pounds and 10 ounces (3.45 Kg.) When I first saw them they were 4 years of age: One of them was

of normal weight for his height, but the other was 15 per cent under weight. One was sharp and witty, and the other was a laggard, and mentally seemed to be of no consequence. He seemed to be mentally deficient, and physically he was certainly so. He had most of the diseases of childhood; his teeth showed no calcification; he was just a poor, undernourished specimen. They had always lived in the same house — what is the difference? An acute infectious disease had developed in one and he got off the beaten track, and was pampered because he was sick. The kindness of the parents almost killed him. He caught up later on under proper management. If he had been mentally deficient, no one could have been able to do anything about it. He simulated mental deficiency, but much was done for him. If he had been biologically inferior, as appearances indicated, he would have been sterilized.

Let me repeat that I believe that an attempt to make any superman or any improvement of a gigantic character is as described by Dr. Burr. If every one keeps on hammering away and adds his little to posterity, and posterity in turn add its bit, the net result, be it what it may, will be good; but I cannot describe it, you cannot describe it and neither can the eugenists.

DR. BARR: Not that Dr. Burr's statements ever need to be reinforced — his reasoning is always sound and his discussions stimulating — but along this same line, a number of case histories were examined at Byberry recently. Some startling cases were discovered. One woman had two sons who had been notorious characters in the recent gang uprisings. There were a number of defective mothers with defective or epileptic children; insane mothers with insane or defective children, and all sorts of similar instances, which is trite information for any one versed in mental diseases.

I believe the sympathy people have for criminals and the front page advertising given them makes them worse. I think it would be to the best interest of the human race if every one was more "hard-boiled." As Dr. Burr has said, bad environment may be overcome if a person has the right stuff in him, and the best of environment will not compensate for inherent defects.

CHICAGO NEUROLOGICAL SOCIETY

Regular Meeting, March 21, 1929

LOYAL DAVIS, M.D., *President, in the Chair*

MODIFICATIONS OF THE VESTIBULO-OCULAR REFLEX IN CRANIAL LESIONS. DR. J. GORDON WILSON (by invitation).

Dr. Wilson contrasted the deviation of the eyes in labyrinthine disease and in cerebellar disease, pointing out the essential and important differences; both deviations he believed were due to loss of function. He pictured the ocular movements characteristic of lesions in the pons and mesencephalon.

In conclusion he gave the results of observations to show that the vestibular reactions in cerebral lesions had both quantitative and qualitative differences, compared with the normal, sufficient to suggest not only the position of the lesion but also the side on which it occurred.

A REVIEW OF THE PHYSIOLOGY OF VESTIBULAR NYSTAGMUS. DR. ANDREW C. IVY (by invitation).

The literature bearing on the physiology of vestibular nystagmus was briefly reviewed. The evidence bearing on the mechanism of stimulation of the cristae was considered, the author arriving at the conclusion that Maxwell's theory was the most tenable. Maxwell's theory maintains that the cristae are stimulated by changes in the tension in the membrane of the utriculus which would be trans-

mitted to the ampulla, especially to the side which bears the crista. This theory can explain all kinds of nystagmus induced by stimulation of the labyrinth, as well as Ewald's classic results, without the assumption of canal currents. It was shown that a correlation exists between the type of nystagmus that results from rotation in the various visual planes in the dog-fish and in man. It was shown that this correlation might be developed further to determine the ampulla or ampullae which are probably stimulated when man is rotated in various planes. The various theories concerning the cause of the quick component of nystagmus were discussed. It was concluded that the quick component is probably due to a reflex via the centers of the eye muscles which are excited by the stimulation of kinesthetic sensory endings in the eye muscles, and is not due to a cerebral reflex arc, the cerebrum exercising its well known inhibitory control over this reflex mechanism.

DISCUSSION

DR. JOHN FAVILL: I have read papers on several occasions on a part of this subject, and never appreciated so well how difficult it is to follow details of this sort when one has not been working with them. Has Dr. Wilson seen the paper by Dr. Leon Meyers, who made vestibular tests on a series of hemiplegic patients and arrived at much the same conclusions in regard to the effect on the quick component of lesions above the midbrain? That is, with a left internal capsular lesion, a patient with right hemiplegia would show normal vestibular nystagmus when rotated to the right, the slow component being to the right and the quick to the left; but if rotated to the left the result was usually a conjugate deviation of both eyes to the left and the absence of the quick component to the right, as would be expected if that component originates higher than the midbrain and is interrupted by a capsullar lesion.

Will Dr. Ivy say something about the otolith nystagmus discussed by Quick? I do not recall his bringing this up as a possible explanation for some of the effects described.

In a purely clinical investigation I made an attempt to bring some systematic order into the crista-eye muscle relationship. I did nothing with any animal except man, and cannot intelligently discuss any of the work on the lower organisms. However, I think that one point should be raised and that is the difficulty of being sure that one ampulla is stimulated in these experiments, because the position of the canals, if one takes into consideration the effect of rotation, requires always some effect on more than one canal.

In the analysis I made of the crista-eye muscle relationship in man, my entire argument started with one assumption—that canal currents could occur. I do not know whether they can or not, but I am certainly not satisfied that they cannot. If that possibility is granted, even though it is a slight shift and that shift lasts but a second or two, I think my explanation of the phenomena that follow rotation in various positions in man is complete and consistent. I can conceive of a slight shift acting on a cupola, thus bending the hair cells which would need twenty seconds to become straightened again.

The one point which I did not emphasize particularly in my last paper, but which I still think is a tremendously strong argument for the relationship presented, is the combination of horizontal and reverse rotatory nystagmus. By using the assignment which I made, I saw that if the head was put about 15 degrees backward and rotated to the right, nystagmus should occur which would combine horizontal slow to right with rotary slow to left. I produced this immediately with a patient. I thought I had discovered something, but found that the same observation had been made by Politzer years ago without explanation and appears in his textbook.

When one finds a crista-eye muscle relationship which is so complex and yet works successfully in predicting such a phenomenon as that, I think that it argues for its correctness.

DR. LEWIS J. POLLOCK: I wish to ask Dr. Ivy one question in relation to de Kleijn's conception of the pattern of movement released by vestibular stimulation. What is Dr. Ivy's conception as to the relation of muscle groups to isolated specific areas of stimulation as compared to the conception of distribution of tone in one or another direction? The muscles concerned in the distribution of this tone may always be constantly reciprocally innervated. An internal rectus muscle and an external rectus of the opposite eye would be employed in producing the deviation to the right. Does this imply that these muscles are directly stimulated by a reflex acting only through specific receptors if one rotates the animal horizontally? If in the decerebrate animal one turns the head to the right, one produces a flexion of the opposite foreleg; if to the left, one produces extension of the foreleg. The conception is that this tonic reflex influences the general distribution of tone, one extensor and one flexor, one to the right and one to the left. Is it not possible to explain the action of the eyeballs by the release of tone in a given direction by stimuli of rotation or heat or cold? The recent work of de Barenne, in which he severed all of the extra-ocular muscles and still produced nygstagmus, speaks somewhat in favor of this.

DR. PERCIVAL BAILEY: When making his report in Paris, de Kleijn said that there is some lateralizing of the vestibular response, and that this is in relation to the hemisphere involved. This would be in accord with Dr. Wilson's observations.

I wish to ask Dr. Ivy if, supposing that the semicircular canals have nothing to do with the response, it is not strange that they should be so geometrically arranged in all these animals.

DR. J. GORDON WILSON: The subject is much too intricate to go into in all its details, so I shall say only that I read the paper of Dr. Meyers and think that it is in accord with my assumptions.

DR. ANDREW C. IVY: Concerning otolith nystagmus, Maxwell has shown that the utriculus can perform the function of the vertical canals when the latter are removed; however, the utriculus cannot perform the function of the horizontal canal. In other words, certain movements caused by stimulation of the vertical canals can be duplicated in the absence of these canals by the utriculus. It is not known whether or not this is true for man.

So far as Dr. Pollock's question is concerned, I can conceive of the situation as it is pictured by de Kleijn, and that the pattern may be affected not only by impulses coming in from the eye muscles but by impulses coming in from various portions of the brain, including sensations from skeletal muscles of the neck. The sensory nerves that innervate the muscles of the eye must obviously be concerned in controlling the muscle pattern, regardless of the mechanism fundamentally concerned.

The question Dr. Bailey brought up is the one we always ask ourselves. The semicircular canals are there and one would expect currents to flow through them. If currents do not flow through them, what are they for? Nevertheless, one has to take cognizance of the fact that with the canals blocked and tied, one does not change the response. That does not necessarily mean, however, that the canal currents do not play a rôle normally, but it shows that the end-organs can be excited in the absence of intact canals. Maxwell's experiment, in which he placed the horizontal canal in a vertical position and observed stimulation only when rotating in a horizontal plane, proves that canal currents or canal inertia effects play no essential rôle in the dog-fish. Because of Maxwell's classic work, I cannot longer teach that the canal current theory is tenable.

NEURINOMA INVOLVING THE MANDIBULAR BRANCH OF THE RIGHT TRIGEMINAL NERVE. DR. H. GIDEON WELLS and DR. PERCIVAL BAILEY.

A man, aged 85, previously unusually well and strong, noticed in January, 1926, a subcutaneous smooth, hard nodule in the right side of the lower lip, which

increased slowly in size. It was removed under local anesthesia by Dr. A. D. Bevan in April, 1926. The lesion, after microscopic examination, was thought to be a chronic inflammatory process, but soon recurred and again increased slowly in size. About June, 1926, numbness was noted with only slight dull pain in the lower part of the right side of the face, which slowly developed and was soon followed by weakness of the muscles of mastication on this side. In January, 1927, he complained of increasing deafness in the right ear without tinnitus or vertigo and developed a right facial palsy, which finally became complete in September, 1927. There was never any headache.

In October, 1927, there were: complete paralysis of the right facial nerve; anesthesia of the entire right trigeminal area; deafness of the right ear of nerve type, and slight weakness of the right half of the soft palate. The other cranial nerves were normal. There was, in particular, no choking of the optic disks. The right labyrinth gave only a sluggish reaction to caloric stimulation. No symptoms of involvement of the cerebellum or pyramidal tracts were present. The recurrent nodule on the lip was removed at the Albert Merritt Billings Hospital on Oct. 11, 1927, by Dr. D. B. Phemister, and microscopic examination showed it to have the structure of a neurofibroma.

The patient was given roentgen irradiation of the right cerebellopontile region by Dr. Rose at the Presbyterian Hospital, without improvement. On Nov. 20, 1927, there was a transient right hemiplegia which lasted only about half an hour. A similar attack recurred five days later, from which he recovered completely. A third attack was also only transitory, but finally, on December 3, he developed a complete right hemiplegia which persisted until death from hypostatic pneumonia on Dec. 15, 1927.

The necropsy, performed by Dr. H. G. Wells, disclosed diffuse acute suppurative bronchitis and early bronchopneumonia, atrophic pulmonary emphysema, bilateral hypostatic congestion and edema, marked senile arteriosclerosis, especially of the cerebral arteries, hypertrophy of both cardiac ventricles, arteriosclerotic atrophy of both kidneys, marked adenomatous hypertrophy of the prostate, passive congestion of the spleen and liver, fibrous episplenitis, diffuse atrophy and fatty infiltration of the pancreas, focal adhesive fibrous pleuritis and peritonitis, diffuse hyperostosis of the right half of the calvarium and atrophy of the right temporal muscle. Examination of the brain revealed no gross cause for the hemiplegia; the microscopic study had not been completed.

When the brain was removed there was found only a slight elevation of the dura mater over the right gasserian ganglion and no other evidence of intracranial tumor. The base of the skull in this region was removed and later decalcified and cut into serial sections by Dr. Friedrich Hiller. The mandibular branch of the right fifth nerve was dissected. It extended as a large cord, varying from 7 to 9 mm. in diameter, throughout the mandibular canal as far as the mental foramen, beyond which it had been largely removed by the surgeon.

The nodule removed from the lip was made up of elongated spindle cells running in interlacing bands. There was no palisading, but the long sausage-shaped nuclei and the myriad of delicate fibrils of reticulin between the cells made the diagnosis of neurinoma certain. The tumor within the mandibular canal was composed of the same spindle-shaped cells in long parallel bundles, but less regular in appearance, while the part of the tumor which had invaded the gasserian ganglion was more anaplastic. The cells were here irregular in outline, with more cytoplasm; many were multinucleated; mitoses were common, and fibrils of reticulin were rare. The tumor had eroded the bone, destroyed the gasserian ganglion and involved the intracranial portions of the seventh and eighth nerves.

The history and examination of this tumor leave little doubt that it arose in the sheath of the mental nerve and spread up the inferior alveolar branch, becoming more active in its proliferation as it went. It finally eroded the petrous bone and destroyed the gasserian ganglion with the seventh and eighth nerves, although remaining extradural.

We have found record of one other neurinoma of the lower lip (*Archivio per le scienze mediche*, 1928). It was removed, and sufficient time has not elapsed to determine whether a recurrence will take place.

DISCUSSION

DR. G. B. HASSIN: Was the intracranial portion of the neurinoma in Dr. Wells' case the oldest or the youngest? The younger the neurinomas, the more cellular they are, and they may even appear malignant. If I understood Dr. Bailey aright, he stated that the intracranial portion was more malignant. The tumor most likely started at the periphery and later invaded the cranial cavity.

DR. J. GORDON WILSON: Did I understand that the auditory function was gone and the vestibular intact? Was the caloric test ever carried out?

DR. PETER BASSOE: I have never heard of a similar case and should like to know whether any of you have seen one reported.

DR. PERCIVAL BAILEY: Replying to Dr. Wilson, I never saw the patient, but it is definitely stated by the pathologist that there was deafness in the right ear, while hearing was not impaired in the left.

I found a report of a neurinoma of the lower lip of exactly the same kind as this, but with no report of the subsequent course after extirpation. Perhaps the patient has not been observed sufficiently long, and the final report may come in two or three years.

Dr. Hassin called attention to the fact that there is a variance in the younger and older portions, and that bears out the impression from the specimen under the microscope. Chronologically, according to the history, the tumor began on the lip and grew up the nerve. The history is categorical on that point, but I think the internal portion was more malignant than the external portion.

DR. H. GIDEON WELLS: In substantiation of what Dr. Bailey said, I will say that the degree of lack of differentiation of anaplasia is progressive up to the site of the gasserian ganglion. The tumor had practically destroyed the petrous bone; it had invaded the eighth nerve, and I think Dr. Hiller found invasion of the seventh nerve.

In regard to the deafness, I have the notes which contain the statement, "There was a definite nerve type of deafness on the right. The right responded sluggishly to the caloric test; the left responded normally."

MANIC-DEPRESSIVE PSYCHOSIS: SEX DISTRIBUTION AND AGE INCIDENCE OF FIRST ATTACKS. DR. HARRY A. PASKIND.

This paper will be published in full in a later issue of the ARCHIVES.

DISCUSSION

DR. ALFRED P. SOLOMON: Were the attacks altered in character in those patients who were affected later in life? Were the depressed phases more marked?

DR. JAMES C. HASSALL: In a survey covering several years in one of the Ohio State Hospitals the percentage was much the same as Dr. Paskind reports. If I remember correctly, most of the manic-depressive patients entered the hospital between the ages of 35 and 40. It is rather difficult to evaluate the diagnosis made in most hospitals, for frequently that diagnosis is made if the patient recovers within a year or two. If not, the cases are usually diagnosed as dementia praecox. I think that the percentage of men and women ran about two to one, but there is an economic explanation for that. If a young wife becomes affected the husband can carry on and keep her in a sanatorium, but if the husband is affected the state hospital is usually the place to which he must go. I think that the older patients are more apt to have pronounced mania.

DR. HARRY A. PASKIND: Most of the patients studied had depression, with very few attacks of mania. The age of the patients entering the hospital has no relation to this study.

PHILADELPHIA NEUROLOGICAL SOCIETY

Regular Meeting, March 22, 1929

C. A. PATTEN, M.D., *President, in the Chair*

TWO CASES OF AMAUROTIC FAMILY IDIOCY, JUVENILE TYPE, IN A BROTHER AND SISTER. DR. LYNN M. HERSHEY.

In reporting these cases, several points seem to be of special interest: (1) the unusualness of the age of onset, 2½ years in the boy, and 3 in the girl; (2) the onset coincident with an acute infection, and (3) the chronicity of the disease.

The diagnosis of amaurotic family idiocy was made because of the concurrence of the following symptoms: failing vision, mental deterioration leading on to imbecility and idiocy, flaccid paralysis, nystagmus, optic atrophy and blindness. Macular degeneration was demonstrated in each case. In addition, both patients showed hypertrichosis on the arms and legs.

These cases were classified as belonging to the juvenile type because of the great chronicity of the disease, although according to B. Sachs the juvenile form manifests itself between the ages of from 8 to 12 years. Obviously, these two cases do not belong to the fatal infantile form of the disease.

CASE 1.—Arden M., aged 8 years, was born after a full-term pregnancy; the delivery was normal. He talked and walked at the age of 1 year and developed mentally and physically until 2½ years, when he had cholera infantum, and was ill for one month; the illness was characterized by fever, delirium, diarrhea, vomiting and thirst. He recovered, but the parents observed at once diminished speech and mental alertness, apparent diminution in visual acuity and inability to walk. He began to creep and had to relearn to walk. Following the acute illness he was greatly emaciated, but in a year's time he rapidly gained physically, but continued to deteriorate mentally. At that time he could scarcely be understood, and was irritable and clumsy. At the age of 4½ years he had an attack of grip which left him weak, and he began to have "falling spells" occasionally, with momentary unconsciousness. At 5½ years, he was unable to feed himself or to walk. Speech became unintelligible, and it was noticed that he was blind.

His parents consulted one nerve specialist after another, who made the diagnoses of "encephalitis" and "meningo-encephalitis."

In September, 1928, examination showed the patient to be underweight and under-size, completely imbecilic and blind; no pupillary response, optic atrophy, spontaneous and constant nystagmus and loss of control of the bladder and bowel functions were noted, and he was speechless except for three words spoken indistinctly—his name and "no" and "yes." He was able to chew and swallow food fairly well, but in all extremities was flaccidly paralyzed. All tendon and abdominal reflexes were moderately but uniformly diminished. The maculae were not visible, but retinal vessels were greatly diminished in size and number. Hypertrichosis of the arms and legs was present.

On March 9, 1929, the patient lay in bed completely imbecilic. To touch, pin prick or auditory stimuli he moved the arms and legs aimlessly about and babbled unintelligibly. He drooled from the mouth and occasionally choked on the saliva which gathered in the throat. There were spontaneous nystagmus and total blindness. The extremities were flaccid, and the muscles were soft and toneless. There was a loss of bowel and bladder functions. The abdominal reflex was absent; all the tendon reflexes were uniformly and greatly diminished. Examination of the fundus under mydriasis showed a white disk and few narrow vessels. The retinas were gray, and in the macular region there were pigmented patches surrounded by a red area. The liver and spleen were not palpable.

CASE 2.—Alta M., aged 6, sister of the patient in case 1, had a normal birth, following a full-term pregnancy. She began to walk and talk at the age of 1 year. At 3, she had an attack of acute tonsillitis, and soon afterward began to lose weight and grew less active physically and mentally. Tonsillectomy was

performed when she was 3½ years of age, but in spite of the operation she grew rapidly worse, becoming nervous, irritable and definitely retarded mentally. Her speech became indistinct and less voluble, and her vision began to fail. She began to drool at the mouth and seemed helpless in feeding herself. The symptoms progressed gradually but persistently to the age of 5. She showed general muscular weakness and had falling spells, with general convulsive seizures.

In September, 1928, examination (Dr. Appeman) showed definite visual impairment, nystagmus, "pale disks" and an abnormally red reflex just around the maculae, not definitely limited in extent, but of a color the same as in Tay-Sachs' disease, though, according to the ophthalmologist, not typical of the same at that time. The muscles of mastication and expression were weak; the face was smoothed out; there was difficulty in swallowing and drooling from the mouth, and the mouth hung open constantly. Speech was indistinct and scanty, and the tongue movements were slow and awkward and somewhat stumbling. The muscles of all the extremities were weak and of diminished tone. The biceps, triceps, knee and ankle reflexes were diminished. The urine and blood count were normal; the Wassermann reaction of the blood, the chemical analysis of the blood and the x-ray picture of the head gave negative results. The patient was under-size and underweight, and showed distinct increased growth of hair on the arms, legs and upper part of the back. She was greatly deteriorated mentally.

On March 9, 1929, the patient did not cooperate, was greatly retarded and cried easily. She kept the fingers in the mouth and drooled constantly. There was no spontaneous speech, but she occasionally replied to questions in monosyllables. She could stand alone but could not walk. She was incoordinate and seemed to be afraid of falling. The biceps and triceps reflexes were greatly diminished. The patellar reflexes were about normal. The achilles reflex was diminished. She was pigeon breasted. There was hypertrichosis of the arms and legs. The ability to feed herself had disappeared during the past four or five months. Occasionally, she lost control of the bladder function. Nystagmoid movements were present on looking to the right. The pupils reacted to light, but showed hippus reaction. Dr. Rudolphy's report was: "Both disks show marked underlying pallor, particularly the temporal portions. The arteries are reduced in caliber and both maculae stand out more prominently than normal—the surrounding area being pale." Liver dulness extended from 2 to 3 inches (5 to 7.6 cm.) below the margin of the rib on the right; the liver was palpable. There was consanguinity of the parents in these children—third cousins.

DISCUSSION

DR. CADWALADER: Tay-Sachs' disease is an uncommon condition. The diagnosis must depend to a great extent on the observations in the eyegrounds.

Dr. Hershey's cases are of the juvenile type, which differ from the infantile form by the longer duration of the disease. Transitional types probably occur in which the characteristic ocular observations may not develop early. There is evidence indicating that the condition is associated with disease of the liver and disturbances of fat metabolism. This was alluded to by Dr. B. Sachs at the meeting of the American Neurological Association held in May, 1928, in Washington, D. C.

DR. L. M. HERSHEY: When I first saw these cases, I considered the diagnosis of Schilder's disease, and then I decided that they were not, and ruled out that diagnosis in favor of the juvenile type of Tay-Sachs' disease, because in Schilder's disease the paralysis is spastic.

A CASE ALLIED CLINICALLY TO TAY-SACHS' DISEASE AND THE RELATED DISEASE GROUPS. DR. MILTON K. MEYERS.

The case I wish to show is that of M. K., aged 2 years and 9 months, a Jewish child of east European ancestry, whose father was born abroad and whose mother was born in New York City. There is no history of consanguinity between the parents, nor is there a family history of nervous or mental disease. There is a healthy brother who is 6½ years old. No brothers or sisters are dead. The mother has had two miscarriages, which she said were self-induced.

The child came to my attention about the middle of February, 1929, at the Dispensary of the St. Agnes' Hospital, and was admitted to the wards for study, from which it was discharged after a few days. It has been seen by me a few times since. It had previously been taken to three hospitals in New York City. At one of the hospitals the diagnosis was rickets and diarrhea. No mention was made of the mental condition.

The pregnancy and labor of the mother were normal, and no instruments were used during delivery. The child was a full-term baby, and was successfully nursed by the mother for three months, after which time it began to develop diarrhea. It was then weaned and given cod liver oil and sunlight. In spite of the continuance of the diarrhea, it thrived fairly well, noticed things, sat up and at the age of 9 months was able to pronounce syllables such as "Da-Da." At that time it fell from a high chair and bled from the nose. It was not unconscious and did not vomit. It continued in its usual state of health for three months longer, when the parents noticed that it experienced difficulty in holding the head up, in sitting up and that it did not follow objects with the eyes as usual. These conditions continued to the time of presentation with no marked improvement. The child had never walked. At the onset and for a time after it, the patient was subject to numerous convulsions or "spells" as the mother called them, which at that time were almost incessant, and in which, according to the mother, "the baby seemed almost as if tied in a knot." A remnant of these attacks remained, but the present spells are minor in degree; they will be mentioned again later. The anterior fontanel closed early; the posterior fontanel remained open for a long time, and closed only recently.

Examination of the patient showed a fairly well nourished child with, however, a well marked Harrison's groove and a rachitic rosary. There were no deformities of the extremities and no bowing. The left forearm, however, was held awkwardly. There was pronounced hypotonia of the muscles of the lower extremities. The head was flattened posteriorly, where there was a depression at the site of the posterior fontanel. The forehead was of the square type. The teeth were not well erupted. The biceps, triceps and knee reflexes were in general diminished. For the most part, on stimulation of the sole of the left foot the great toe went up, but one could not feel sure that this represented a genuine Babinski reflex, although this reaction differed from the normal plantar flexion on the right. The skin was normal; there was no seborrheic eruption.

The child was sensitive to pain. It showed, however, a marked lack of registration of some other sensory impressions. For instance, one would strongly suspect it to be blind. Two ophthalmologic examinations by Dr. George Kelly at the St. Agnes Hospital showed that the child had normal eyegrounds. Dr. Kelly was convinced that the child did see to some extent. If this were so, there was at all events a distinct lack of visual registration. Rarely, if ever, did the eyes follow an object. The hearing was recorded by Dr. Benjamin D. Parish as follows: "Both drumheads normal, no infection in ears, nose and throat. The child apparently hears, but degree of hearing impossible to state. Unable to make patient concentrate." There was also a lack of grasping for objects when the back of the hand was touched by them, although they were sometimes grasped when they were placed directly in the patient's hand. The patient was occasionally quiet, but for the most part when it was awake it tossed the extremities about as if it derived pleasure from these movements. A favorite position for it to assume when lying on its back was with the head turned toward the left, the left upper extremity being held out in the line of what would correspond to the gaze. I noticed at times a tendency for the eyes to converge, but there had been no nystagmus.

In addition, there were what the mother called "spells." These might occur three or four times during the day, and each spell might consist in three or four separate attacks in the course of ten minutes. I have seen one such series of attacks. In them the patient's head and mouth were drawn to the left, and the left upper extremity went toward the left.

Two spinal punctures were done. The first showed a contamination with red blood cells; the fluid was under a pressure of 10 mm. of mercury. The second puncture was done by Dr. Gershon Ginsburg, who found the fluid under a pressure

of 10 mm. of mercury, 9 cells per cubic millimeter. The fluid was clear, had no yellowish color, contained sugar and yielded a negative Wassermann reaction. The patient's blood and the bloods of both the parents were negative to the Wassermann test. The patient's blood count, as made by a laboratory technician, showed: red cells, 3,970,000; hemoglobin, 70 per cent, and white cells, 10,000, of which 70 per cent were polymorphonuclears, 20 per cent small lymphocytes, 8 per cent large lymphocytes, 2 per cent transitionals and no eosinophils.

Chvostek's and Trousseau's signs were negative. Erb's sign was negative, at least the muscle supplied by the ulnar nerve showed no deviation of the electrical reactions, and there was cathodal closing contraction to 1 milliampere but not to 0.5 milliampere.

X-ray pictures of the head showed nothing noteworthy, beyond emphasizing the peculiar shape of the head.

The case is interesting as presenting a problem for diagnosis. The child is of Jewish parentage, but there is as yet no evidence of similar disease in the family. Tay-Sachs' disease is to be thought of, but as yet there are no changes in the eyegrounds, and the child continues to be well nourished in spite of the fact that it has withstood rickets and it has arrived successfully at an age at which Tay-Sachs' disease does not occur. There is no ordinary idiocy, since the child was normal for some time after birth, and before it developed this condition of amentia it has been in the prestages at least of the attainment of articulate speech. The skin is clear, so that the thought of tuberous sclerosis does not impress one especially. It is unlikely that rickets alone could produce the profound mental changes and the possible organic changes in the case. Tumor of the brain is almost certainly not present, the subarachnoid pressure is not high and there are no signs such as changes in the eyegrounds or vomiting. The possibility of an intracranial hemorrhage in the course of a convulsion during the rickets would have led to greater spasticity and would not have been likely to have led to lack of sensory registration so profound as that in this case. There remain Tay-Sachs' disease and the group of diseases associated clinically with the Tay-Sachs' type. Of these, the types described by Krabbe and by Pelizaeus and Merzbacher are of the familial type, that described by Schilder of the nonfamilial type. The case here does not show any of the spastic or myoclonic phenomena characteristic of Schilder's disease, nor does it fit in with the typical cases of the diseases just mentioned.

If it is a case of Tay-Sachs' disease, it does not show changes in the eyegrounds and is atypical. In common with Schilder's disease and some of the other groups, the case shows hypacusis. Although hypacusis may occur late in Tay-Sachs' disease, the early cases are characterized by an especial sensitiveness to auditory impressions.

In spite of the fact that Tay-Sachs' disease and the various other groups that resemble it clinically differ somewhat in their pathology, the question arises whether the pathologic changes in these conditions, affecting as they do both the gray and the white matter in Tay-Sachs' disease and the white matter alone in some of the other groups, may not be affairs of degree and of seat of localization of disease processes, rather than affairs of kind, and whether transitional cases between the various groups may not occur. At least this case shows that in view of the fact that various groups of cases associated clinically with types of amentia resembling that seen in cases of Tay-Sachs' disease have been described, a given case may be extremely difficult to classify from clinical symptoms alone, in the absence of a necropsy.

CEREBELLAR SYMPTOMS IN TUMOR OF THE FRONTAL LOBE. D. HELEN E. RIGGS.

Many cases of tumor of the frontal lobe present signs of cerebellar involvement. This may vary from slight asynergia to a true cerebellar ataxia. At times the cerebellar signs may so mask the picture that operation is performed on the posterior cranial fossa. The cerebellar signs have been variously interpreted as due to contrecoup pressure, increased intracranial pressure with downward pressure

of the falx and to involvement of the frontopontocerebellar tracts. It is in defense of this last hypothesis that this case is presented.

Annie Y., a white woman, aged 40, was admitted to the service of Dr. J. W. McConnell at the Philadelphia General Hospital in May, 1927. At the time of admission, her husband stated that since 1925 her entire disposition had changed. She had become extremely slovenly in habit and in dress; her memory had failed; she sat in one spot all day; her voice had become difficult to understand, and she was incontinent of urine.

On examination, the patient showed a clouded sensorium, her memory for recent events was poor and her mood varied between a "Witzelsucht" and a depression. She presented a staggering gait with a tendency to fall forward. There was a marked body sway with the eyes open as well as with them closed. A fine static tremor of the entire body was also noted. Speech was slow, slurring and scanning. Her face was expressionless and masklike, to the degree of suggesting a postencephalitic parkinsonism. There was also a weakness of the lower part of the left side of the face and a tremor of the tongue. There was no anosmia. Ocular movements were well performed with a transient nystagmus at the extremes of rotation. Examination of the ocular fundi showed an early papillitis in the right eye and a swelling of 0.5 diopter in the left eye. On purposive movement, the patient showed a marked intention tremor of both upper extremities. There was also a tremor of the extended hands. The left upper extremity showed a relative weakness when compared to the right. All deep reflexes were exaggerated, but the abdominal reflexes were lost bilaterally. There were no abnormal reflexes nor were there any changes in sensation. The patient was completely incontinent of urine. The spinal fluid pressure was 350 mm. (water).

Over a period of a week, the patient gradually became semicomatose. There was a general mental and physical apathy; the patient did not even swallow food placed in her mouth unless specifically told to do so. During this time, there were transient periods of verbal perseveration and nominal aphasia. Spasticity developed in all four extremities with a lead pipe type of rigidity. The slightest touch threw the limb into intense and sustained clonus. A Bárány test localized the lesion in the right cerebral hemisphere. After an unsuccessful attempt to tap the lateral ventricles, a palliative decompression was performed by Dr. F. C. Grant.

The patient lived for four weeks after the operation, with an increasing spasticity and rigidity of the neck, jaws and extremities.

At postmortem examination, an enormous endothelial tumor was found. This involved almost two thirds of the left frontal lobe and one half of the right. The mass apparently sprang from the dura in the midline, and slowly compressed the frontal lobes in its growth. It was easily enucleable. The cerebellum showed no gross lesion, nor was there any pressure cone. There was an erosion of the floor of the sella turcica and an apparent spontaneous decompression in this manner. On section, it was seen that the anterior part of the corpus callosum and the anterior part of the caudate were involved by pressure. The anterior horns of both lateral ventricles were encroached on by the tumor mass.

In an attempt to discover the cause of the cerebellar symptoms, the midbrain was studied by the Weigert stain. By this method, a clearcut degeneration of the inner fifth of the foot of the cerebral peduncle was found. This is the area, according to von Monakow and others, which is occupied by the frontopontocerebellar tract.

At present, we have in the laboratory a series of twenty cases of tumors of the frontal lobe which show no cerebellar involvement but which clinically present cerebellar symptoms. Study of the frontopontocerebellar tracts is now being carried on in as many of these as is possible. The case reported is presented as a preliminary report.

INTERPRETATION OF THE ENCEPHALOGRAM IN THE DIAGNOSIS OF INTRACRANIAL LESIONS. DR. F. C. GRANT and DR. W. J. GARDNER.

The procedure of encephalography is fairly simple, but there are many minor variations in the operative technic in the various clinics where it is employed. On the neurosurgical service of the University Hospital it is customary to employ a

water manometer to keep a constant check on the pressure during the procedure. An estimation of the intraspinal pressure in the horizontal position is always made before encephalography is undertaken. If the pressure is above 260 mm. of water, encephalography is not advocated. Especially is this true if an obstructive hydrocephalus is suspected.

Given an intraspinal pressure of 150 mm. of water in the horizontal position, the pressure in the sitting position will be found to be about 450 mm., or approximately three times the pressure in the horizontal position. This will place the meniscus in the manometer at a level about opposite to the seventh cervical vertebra. That the meniscus in the manometer does not assume a level even with or above the crown of the head would seem to indicate that the intracranial pressure of the normal subject is negative in the erect position. Certain observations which we have carried out would seem to confirm this assumption.

Roentgenograms are always taken with the patient in the erect position in the same chair in which the operation was performed. On account of the configuration of the ventricles, it is impossible to obtain a good picture of the descending horns in the erect posture; so if this is desired, further films must be made with the patient lying on his side.

A thorough knowledge of what constitutes a normal encephalogram is necessary to interpret properly the results of this procedure. Abnormalities in encephalograms consist of: (1) an increase or decrease in the size of a part of the subarachnoid space; (2) an increase or decrease in the size of a part or all of the ventricular system; (3) a deformity or a shift in the position of a part of the ventricular system, and (4) absence of filling of a part or all of the ventricular system.

These abnormalities are easily seen on the encephalograms. The difficulty lies in giving them their proper interpretation. Plausible explanations would seem to be as follows: It is apparent that a permanent increase in amount of the cerebrospinal fluid can occur only as a result of shrinkage in volume of the nervous elements; that is, provided enlargement of the bony cranium does not occur. Why does this shrinkage sometimes occur on the cortex and sometimes about the ventricles? In the traumatic group one may find an explanation. Given a post-traumatic patient with an increased amount of air over the cortex, as shown in the encephalogram, one might assume that he had suffered a contusion of the cortex with resultant cicatricial contraction causing cortical atrophy and therefore an increased amount of fluid over that cortex. In another post-traumatic case, one may find an enlargement of the ventricles. This, we believe, may be the result of a previous period of generalized increase in intracranial pressure, as increased pressure seems to cause atrophy of the white matter while the cortex remains little affected. With this atrophy of the white matter occurring close to the ventricle, the latter naturally enlarges.

A shift of the midline structures, if present, is usually toward the side of the greatest atrophy and is obviously the result of cicatricial contraction of the hemispheres toward which the displacement occurs. Exceptions to this are cases of tumor of the brain or other space-filling lesions which cause a displacement to the opposite side.

The absence of air over one cortex cannot be explained as a fusion of the pia and arachnoid in that area. We have seen at least three such cases at the operating table in which the subarachnoid space appeared perfectly patent and even dilated. In these cases, therefore, the blockage to the entrance of air must be located at a lower level, perhaps in the beginning of the fissure of Sylvius.

The area of cortical atrophy need not always be located in the region in which one sees the collection of air on the encephalogram. The air injected naturally rises to the highest point. Therefore, in cortical atrophy of the cerebral hemispheres even though the atrophy is located at the base one would expect to find the collection of air at the vertex if the films are taken in the erect posture. Also, in cortical atrophy of the cerebellum, the air rises to the highest point which it can easily attain; namely, just beneath the tentorium.

The explanation was offered by one of us (Gardner: ARCH. NEUROL. & PSYCHIAT. **21**:456 [Feb.] 1929) that the winged appearance of air in the posterior fossa is due to a collection of air in the subdural space beneath the tentorium, which air was introduced into the subdural space of the spinal canal at the time of operation. This explanation is probably not correct as the high incidence of this appearance in cases of post-traumatic cerebral atrophy would seem to preclude the possibility.

Review of eighty cases since January, 1927:

Post-traumatic sequelae	27 cases
Suggestive of tumor of the brain	23 cases
Essential epilepsy	10 cases
Psychoneurosis	8 cases
Mentally deficient	5 cases
Cerebellar aplasia	4 cases
Cerebrospinal syphilis	2 cases
Toxic amblyopia	1 case
	80 cases

Therapeutic results in thirty-seven cases; average follow-up time, seven months:

Post-traumatic	27
Essential epilepsy	10
	37

Postoperative results in fifty-seven cases:

	Convulsions	Headache	Tinnitus	Vertigo
Total	26	14	6	11
Number of follow-ups	17	10	6	9
Improved	13	8	4	7
Percentage improved	76	80	67	77
Worse	1	0	0	0

Diagnostic value in twenty-three suggestive of tumor of the brain:

Localized	6
Falsely localized	1
Ventricles failed to fill	5
Tumor of the brain excluded	11
	23

Two of the unsatisfactory cases were subsequently localized by a ventriculogram.

In summing up the situation, therefore, we might say that encephalography is of value to the neurosurgeon in that it tells him when not to operate in doubtful cases. Second, it frequently tells him when and where to operate in doubtful cases. Third, it aids him to recognize a number of interesting nonsurgical conditions. Fourth, it seems to have at least a temporary beneficial effect in some cases of post-traumatic headache, epilepsy, tinnitus and vertigo.

DISCUSSION

DR. F. C. GRANT: From our experiences with encephalography, one or two clear impressions have been gained. First, is it safe to perform encephalography in a case of suspected tumor of the brain whether increased intracranial pressure exists or not? We think definitely that if pressure can be demonstrated encephalography should be used only with extreme caution, if at all. Furthermore, even if pressure is not noted and if a definite defect in ventricular outline indicating the presence of a tumor can be shown to be present by this method an immediate

operation for extirpation of the lesion is indicated. Unless this is done a severe reaction, stupor and signs of increased pressure may ensue. Particularly are reactions of this type noted when gliomatous tumors are present. It is just as important to operate promptly following localization of a tumor made by encephalography as it is when ventriculography is employed. Because we feel the need for immediate surgical intervention if a tumor can be localized we prefer not to use encephalography in cases of tumor. Encephalography, in our opinion, produces a greater degree of shock to the patient than ventriculography. Those subjected to the former test are in many cases unfit for a major operative procedure for from twenty-four to forty-eight hours. This is, in our minds, the greatest drawback to the lumbar insufflation of air.

Furthermore, in those cases of pressure in which we have attempted encephalography there have been a number of cases in which the ventricles failed to fill. Therefore, a localization by this means proved unsuccessful. Dr. Gardner's figures bear out this statement.

In patients in whom pressure does not exist, however, encephalography is the best method of outlining the ventricles, subarachnoid spaces and basilar cisternae. In cases of epilepsy, post-traumatic headache, vascular disease and so forth, beautiful outlines of the fluid spaces of the brain can be obtained; however, these are nonsurgical conditions. Encephalography is of more value to the surgeon in enabling him to determine what patients should not be operated on than it is in helping him to localize lesions on which operations can be performed.

DR. TEMPLE FAY: We are indeed fortunate in having such a beautiful collection of x-ray films, and the members of the society will not find elsewhere such perfect roentgenograms. The films which I have seen in other cities and those published from clinics abroad cannot compare with these. Much of the detailed interpretation which is now possible in encephalography is due to the work of Dr. Pancoast and Dr. Pendergrass of the University Hospital, who have evolved a means of taking these plates by the use of an upright Bucky diaphragm, with standardized distance and tubeshifts. Stereoscopic films make it almost possible to visualize the brain itself.

It is interesting to note the development of encephalography in Philadelphia. Dr. Wartenberg visited Philadelphia four years ago and described his results and method. Three and a half years ago, I undertook my first encephalography, and since that time I have performed more than 100 of these operations. During this time, we have developed the technic of the procedure, as well as the roentgen technic, to the point which you now see, and it has become necessary to interpret the observations. Last summer Dr. Pendergrass and I spent two months in going over all of the films in detail, and analyzing the clinical histories. We traced out the pathways and charted the observations, so that from these observations there has arisen the interpretation which Dr. Grant and Dr. Gardner have set forth.

Dr. Gardner has mentioned one of the factors which came under discussion regarding air, which we believed to be in the cisterna venae magnae cerebri, and within the arachnoid. Dr. Gardner believed that the air seen at this point was under the tentorium and outside of the arachnoid, and reported so in February, 1929 (ARCH. NEUROL. & PSYCHIAT. **21**:456 [Feb.] 1929). I was of the opinion that the shadow cast was within the arachnoid. Since that time we have found a compromise in our views, so that Dr. Gardner and I agree that the shadow is due to air beneath the arachnoid and beneath the tentorium. This clears up a point of great interest and indicates the collection of air to be over the upper surface of the cerebellum.

I think that Dr. Gardner should be congratulated on the presentation of the therapeutic results. There has been much discussion during the past few months as to whether encephalography was a safe and justifiable procedure. With Dr. Frazier's series of eighty cases here reported and my own series of 107, making a total of 187. I have had one fatality in my experience, a patient who died three days after encephalography and proved to have a large glioma recognized by the encephalogram and verified at necropsy. Dr. Grant has called attention to another death, also from a glioma.

The contraindications, if carefully observed, should safeguard this procedure. Encephalography should not be done when intracranial pressure is increased above 20 mm. of mercury in the prone position, and it should not be attempted in lesions of the posterior fossa. Fluid should never be sucked from the spinal canal by a syringe.

By means of encephalography, we have been able to diagnose organic conditions of the brain which have been impossible to demonstrate otherwise, and in proper hands the procedure is safe and of great value. I thoroughly endorse Dr. Grant's views regarding precautions, and wish to congratulate Dr. Grant and Dr. Gardner on this interesting and excellent presentation.

DR. CADWALADER: There is no doubt that encephalography is of great assistance in the diagnosis of intracranial disease, but I believe that it is important to call attention to the fact that its chief value is only to reveal abnormalities in the relationships of the cerebral cavities, and the distortions of the cerebral tissues that may be present. The nature of the disease responsible for such alterations must be deduced by the clinical signs. The interpretation of some of the minor degrees of alterations that have been demonstrated is uncertain, because the existing knowledge of the course followed by the air in the intracranial and cerebral spaces, and the possible variations that may occur under normal conditions, are still indefinite. The condition referred to as cortical atrophy seems to me to imply shrinkage of the cortex of the hemispheres. It is often reported from the x-ray laboratory, yet corresponding clinical symptoms may be absent. Atrophy of the cerebral tissues, especially the cortex, may occur, as has been proved at autopsy in different diseases, especially in association with vascular disease in elderly patients. Not infrequently there are no clearcut clinical symptoms attributable to such a condition.

I urge caution in the interpretation of the minor degrees of so-called cortical atrophy as depicted in the x-ray plates, and one should not attribute too much to this observation alone until more experience has been gained. Postmortem examinations have not been obtained in many cases in which encephalograms were previously made.

Dr. Gardner has reported the cases of a certain number of patients with essential epilepsy who were greatly benefited after encephalography was performed. The frequency of epileptic seizures is notoriously variable; it can be influenced temporarily by many different procedures. For example, etherization alone may have this effect in some instances.

DR. R. WAGGONER: I should like to call attention to a contraindication to encephalography which has not been mentioned by Dr. Grant or Dr. Gardner. In vagotonic persons, collapse may occur after the injection of a certain amount of air. In one of my cases, after the injection of 90 cc. of air, the patient went into collapse, and it was necessary to give him stimulants and to institute artificial respiration. He eventually came around all right. Shortly after this experience, I read an article in the *Revue Neurologique* in which vagotonia was stressed as a contraindication. A later examination of my patient showed that he was, beyond doubt, a vagotonic person.

TUBERCULOMA OF THE BRAIN, WITH REPORT OF CASE ELEVEN YEARS AFTER OPERATION. DR. S. T. KWAN.

An unusual case of tuberculoma of the cerebellum in which the patient was operated on in the neurosurgical clinic of the University Hospital, resembled certain cases recently reported in the literature. The patient, aged 5 years, was seen in March, 1918. For thirteen months, he had been complaining of headaches of increasing severity. At first the headaches occurred usually at night or in the early morning, every two or three days; later they occurred every day and were accompanied by vomiting. Three months before admission to the hospital, he developed an internal strabismus, and his vision became noticeably poor. He had difficulty in getting around and on several occasions fell on account of dizziness. When walking, he leaned to the left, and when he fell it was to the same side. The past history was entirely without significance.

Examination showed the patient to be a well nourished boy. He complained of dizziness on being put in a sitting position. Neurologic examination indicated the presence of a tumor in the left cerebellar lobe.

At operation, Dr. Frazier exposed a large solid tumor in the region suspected. The growth was so large that it had to be bisected before its removal was effected. The pathologic report of the specimen was tuberculoma.

The progress of the boy has been followed regularly, and at no time has there been any symptom suggestive of the development of a tuberculous meningitis or the return of the growth. At the time of presentation, the patient was a healthy boy, aged 17, who did well in school, and had survived the operation for eleven years.

F. N. Anderson (ARCH. NEUROL. & PSYCHIAT. **20**: 354 [Aug.] 1928) called attention to the fact that according to statistics fully 77 per cent of the patients in that series were adults and, further, that the cerebellum occupied third place in frequency of involvement.

DISCUSSION

DR. CHAS. FRAZIER: The survival of this patient so long after the removal of a tuberculoma of the brain reminds one of the saying "One swallow doesn't make a summer." I was interested especially in Dr. Kwan's statistics. In the first place, it seems apparent that the majority of tuberculomas have not been found in the cerebellum, and second the majority do not occur in children. These two facts are contrary to what had been our previous conception. It is surprising, of course, that this boy has survived so long, since the prognosis of tuberculoma of the brain is so notoriously bad. I acknowledge a blunder in the performance of the operation in removing the tumor in sections. Of course, the tumor should have been removed intact. At the time, however, I was unaware that we were dealing with a tuberculoma.

DR. N. W. WINKELMAN: I should like to modify Dr. Kwan's recital of Dr. Anderson's statistics. The work was done in my laboratory, and, in all fairness to Dr. Anderson, he made the emphatic statement that the percentage of children who come to autopsy at the Philadelphia Hospital is smaller in comparison to that of adults. Otherwise, Dr. Kwan's statistics are correct as given.

DR. WALTER FREEMAN: Dr. Kwan might have done well to emphasize the multiplicity of lesions in cases of tuberculosis of the brain. This fact distinctly impairs the possibility of a favorable outcome in such cases. I have seen but one tuberculous lesion of the brain that I could consider healed, this being a calcified nodule in the temporal lobe histologically resembling the healed lesions in the lungs. Why the healing process is so poor in the brain is not clear, but it may have to do with the deficient connective tissue present in the organ.

DR. S. T. KWAN: I am grateful to Dr. Winkelman for calling attention to a point regarding the statistics in Dr. Anderson's paper—a point I am not able to touch on in view of my paper being such a short one. I appreciate the fact that there are far more adult patients than there are children in the Philadelphia General Hospital. Dr. Anderson made this point clear in the first few paragraphs of his paper, and I did not have time to make the comparison.

A CLINICAL STUDY OF MIDLINE CEREBELLAR TUMORS IN CHILDREN. DR. F. C. GRANT.

This report is based on a series of fifteen children who harbored tumors verified as medulloblastomas. The tumors were all found in the midline between the cerebellar hemispheres and arose from the roof of the fourth ventricle. Microscopic study showed a typical picture of medulloblastoma.

The histories of these children are so uniform as to have definite significance. At the onset, the average age was 8 years, the eldest being 15, the youngest, 3. There was little or no difference between the sexes. As these tumors develop in size they at once impede the circulation of the cerebrospinal fluid. As a result the

earliest impressive symptoms are those of pressure—vomiting attacks with headache. These attacks of vomiting and headache are usually considered by the attending physician as due to gastro-intestinal disturbances, and the child is treated accordingly. Curiously enough the vomiting and headache come on intermittently as though the tumor blocked the flow and caused pressure symptoms, and then the fluid forced itself past the obstruction, with relief of tension.

Since the cranial sutures in young children have not completely closed, as pressure develops compensatory separation occurs and the head enlarges and becomes boxlike. It is fortunate that the sutures do separate as pressure develops, for otherwise many more of these children would be totally blind before the true nature of the condition was recognized. Enlargement of the head relieves pressure on the optic nerves to some extent and prevents prompt and early visual loss. Furthermore, at this age visual loss does not mean much to the patient and as it develops gradually does not cause much complaint. Little by little the parents notice that the child is becoming clumsy, falls more easily and the gait is uncertain. More than one third of the patients in this series developed a diplopia which was often the first evidence leading to the suggestion that the vomiting and headache might be due to an intracranial rather than a gastro-intestinal condition. Finally, an examination of the eyegrounds is completed, which reveals a choking of the disks, confirming the presence of intracranial pressure. Admission to the hospital usually follows. The average period for the development of symptoms prior to hospitalization was five months, the longest period ten months and the shortest period, one month.

On first examination, a shrewd guess may be hazarded as to the position and nature of the lesion by any one who has seen many of these cases. The enlarged head with the definite cracked pot percussion note, the marked cerebellar gait with ataxia more pronounced in the trunk and legs than in the arms, the hypotonia and areflexia, the suboccipital tenderness and often slight retraction of the head in a child with a history of sudden onset of pressure symptoms present an unmistakable clinical picture. That the process of education in this matter was slow is evidenced by the fact that in two of the cases in this series a diagnosis of suprasellar lesion was made and an operation carried through to expose this region with disastrous results.

With regard to the cerebellar symptoms, it is the impression on the part of those who examined these children that the trunk and legs are definitely weaker and more ataxic than the arms. The extremities were usually equally involved. A unilateral predominance of cerebellar symptoms was unusual. A tendency to fall backward was particularly noted in six instances. Considering the position of the tumor in the midline involving the vermis, the fact that the ataxia was most marked in the trunk and legs would bear out the claims of recent investigators that this area of the cerebellum had a specific control over these regions. Nystagmus was noticeable by its absence in eight of the fifteen cases. That nystagmus may be absent in midline cerebellar lesions should be remembered, for it has always been considered almost a pathognomonic sign of cerebellar disease. The lack of this symptom went far toward clinching an incorrect diagnosis in one of the patients under consideration.

In two patients, cerebellar fits were noted with retraction of the head and tonic spasm with stiffness and rigidity of all the extremities.

The accessory examinations, Bárány tests, roentgen examinations, eyegrounds and perimetric tests gave no information of value. In fact, the Bárány tests, done in seven patients, placed the lesion above the tentorium in four, indicating the cerebellum as normal. Fundoscopic studies merely confirmed the presence of increased intracranial pressure by demonstrating choked disks. The perimetric tests, when possible, simply showed concentric contraction of the fields. Roentgen studies revealed convolutional atrophy and separation of the sutures, and in three cases because of marked erosion of the sella showed that the tumor might be in this region. That lesions of the posterior fossa causing a block and dilatation of the third ventricle may thereby cause disappearance of the clinoid process should always be kept in mind. Furthermore, pressure in this region by a dilated third

ventricle may produce evidence of pituitary dysfunction by pressure on the pituitary. This may make the differential diagnosis still more confusing. Ventriculography may help one to arrive at a correct localization, although in one case in which it was attempted misinterpretation of the air shadows resulted in a supratentorial operation. If air is to be introduced, it should be done by ventricular tap and not by encephalography. From the position of these tumors, medullary compression is a constant danger. Lumbar puncture, even for pressure reading, should be avoided. In a recent case, lumbar puncture and a Bárány test were done within twenty-four hours. The child suffered from a medullary collapse, and an emergency suboccipital craniectomy was necessary to save its life.

The diagnosis is made from the history, the abruptness of onset, the high choked disk and the cerebellar symptoms although they may be vague and nystagmus may be absent. Furthermore, it is known that cerebellar tumors are more common than suprasellar lesions in children.

Once the diagnosis is made, the treatment, in my opinion, is surgical. Roentgen therapy is effective in controlling the growth of these medulloblastomas—in one case the tumor was held in check for two years by this treatment alone. In another instance, however, medullary collapse and subsequent death followed deep roentgenization without operation. Furthermore, while medulloblastomas are the common tumor type in this region, solid astrocytomas are frequently encountered. These tumors do not respond favorably to the roentgen rays. Valuable time may be lost in treatment and the child may be so weakened and so much vision sacrificed by the continuing intracranial pressure that subsequent operation will not be effective. If the tumor is radiosensitive, operation, relief from pressure, verification of the lesion and then institution of roentgen therapy is the proper sequence of treatment.

DISCUSSION

DR. N. W. WINKELMAN: Dr. Grant has collected an interesting series of cases. I think that I made the pathologic diagnosis in most of them. For the last American Neurosurgical meeting in Philadelphia, I examined some of these tumors which I was fortunate enough to get from the neurosurgical service of the University Hospital before and after roentgen treatment, and I was surprised to find the great amount of good one can do by appropriate roentgen therapy.

In regard to Dr. Grant's statement about medulloblastomas, I do not have to hesitate long in making a diagnosis of tumor of this sort when I see a tendency of the cells to disseminate in the subarachnoid space. I have not seen this particular feature in any other group of glial tumors. The spinal cord which Dr. Grant showed is one of the most interesting in our laboratory. That cord, from the top to the bottom, was one mass of tumor tissue, but little normal cord structure could be seen, and yet, that boy had few clinical symptoms.

TUMORS OF THE OCCIPITAL LOBE: A REVIEW OF FORTY CASES. DR. CHARLES H. FRAZIER and DR. RAYMOND W. WAGGONER.

This paper calls attention to the increasing percentage of tumors accurately localized and exposed at operation and, as a corollary to this, the gradual elimination of subtemporal decompression operations. This operation, once heralded with so much enthusiasm, had many shortcomings, and is now resorted to only occasionally.

In a review of the literature of the past ten years, the paucity of contributions to the subject in question was noted. There were a few reports of isolated cases, but only one substantial paper. This was from the pen of Puusepp and included a series of only eight cases.

Included in the survey of forty cases of tumor of the occipital lobe were nine cases in which the tumor had probably originated in the temporal lobe and had invaded the occipital lobe from its origin in the parietal lobe. An abstract of the essential observations in this series is given.

Concerning the pathologic nature of the tumors in the series: 44 per cent were classified as gliomas, 26 per cent as fibroblastomas, 11 per cent as cysts, 17 per cent

as sarcomas, 3 per cent as tuberculomas and 2 per cent as metastatic carcinomas. A review of some of the earlier material classified as sarcomas would probably prove some of these to be gliomas. In two of the series there were multiple tumors.

Concerning the pressure phenomena, in all except thirteen there was a papilledema of varying degree, the lowest being 1 diopter, the highest, 7. In the majority, the elevation of the disks varied from 3 to 5 diopters. Headache was mentioned as a conspicuous symptom in thirty-six. In nine of the series, six of the occipital lobe, the pupil was larger on the contralateral side. There were no cases of central blindness. Retinal hemorrhages were recorded as characteristic of tumors of the occipital lobe. The inability to turn the eyes from the lesion, as mentioned by some authors as a sign of localizing importance, was not observed.

As the convex surface of the occipital lobe is in a silent area, it is to be expected that some of the cases presented no definitely localizing signs; there were three of these.

Convulsions were recognized as a symptom of tumor of the brain, but the frequency is generally estimated at 10 per cent. In this series, one-fourth, or 25 per cent, had convulsions and in one case a jacksonian seizure was the only evidence as to the laterality of the tumor.

In a number of cases there was a reasonable doubt as to the laterality except for adjacent symptoms, and when the tumor involved the parietal lobe, these were of considerable significance; included in these symptoms were disturbances of stereognostic perception, 7; hemiparesis, 6; hemianesthesia, 5; protrusion of tongue to one side, 3, and lower facial weakness, 4.

The most common sign of tumor with invasion of the temporal lobe was aphasia. There were five instances of motor aphasia, five of motor and sensory aphasia, and four of alexia interpreted as involving the cortical association tracts. The combination of hemianopsia and visual aphasia points to a tumor in the anterior portion of the occipital lobe. There was only one instance of gustatory attacks.

Confusion might arise from the presence of symptoms suggesting dysfunction of the frontal lobe, such as mental confusion, 4; memory defects, 5; irrational states, 3; personality changes, 3, and mental deterioration and emotional disturbance, 2.

The association of signs of cerebellar dysfunction is of especial interest in a discussion of the localization of tumors of the occipital lobe. These are often so conspicuous it is surprising that a mistake was made in only one instance when the cerebellar fossa was first explored. The presence of cerebellar symptoms indicates a position of the tumor in close relation with the tentorium cerebelli and is an important guide to the operator. In this connection ataxia was mentioned twice, awkwardness of movement of the hand once, staggering gait five times, past pointing and asynergia each once and nystagmus four times.

HEMIANOPSIA AND VISUAL HALLUCINATIONS. DR. R. W. WAGGONER.

It is generally conceded that hemianopsia is the most important localizing sign of a lesion situated in the path of the visual impulse. The lesion may produce quadrantanopsia, which may be considered as an early manifestation of an eventual hemianopsia or it may produce a real hemianopsia. If the lesion is posterior to the optic chiasm, the quadrantanopsia or hemianopsia must be homonomous, and thus a homonomous hemianopsia may be produced by a lesion that involves the optic pathway anywhere posterior to the optic chiasm. The lesion may be one of many types. None of the cases in the series studied seemed to bear out the conception that hemianopsia of occipital origin is less clearcut than that of lesions farther forward.

Visual hallucinations occur in lesions of precisely the same nature as those which produce hemianopsia, and in fact often occur either in association with hemianopsia or as a precursor of it. Visual hallucinations, however, may occur as the result of lesions that involve any part of the visual apparatus. In this series visual hallucinations occurred more frequently in lesions of the occipital lobe than in lesions of the temporo-occipital lobe. They were not found nearly so frequently as hemianopsia.

In reviewing this series of cases, it was concluded that hemianopsia and visual hallucinations though the most constant and valuable of all symptoms of the occipital lobe were of greatest value in diagnosis only when considered in association with other symptoms.

DISCUSSIONS

DR. TEMPLE FAY: Dr. Waggoner has brought up a most interesting phase of this problem concerning lesions producing visual hallucinations. Henschen reported perhaps the largest series of lesions of the occipital lobe in his monograph on the visual system. He tried to establish that the lesions producing visual hallucinations corresponded to the hemianopic field; in cases in which the hemianopsia was homolateral to the gross lesion, he found what he considered sufficient evidence in minute degeneration of the unaffected occipital lobe to account for the hallucinations that did not occur in the blind field.

It is well recognized that hallucinations are not always referred to the blind field. Brouwer's recent work on the primary optic centers would suggest a possible reason for their appearing on the same side, or opposite to the lesion.

In the paper by Horrax, covering I believe seventy cases of tumor of the temporal lobe, there were seventeen patients with visual hallucinations. He concluded that visual hallucinations were to be considered as indicative of a lesion of the temporal lobe, on the ground that the hallucinations, if "formed," were due to stimulation of higher psychic centers.

It is Cushing's belief that crude hallucinations of light and color are due to involvement of the optic radiations behind the primary centers. If one compares the thirty-six cases in Henschen's series of tumors of the occipital lobe, one finds that those giving hallucinations were large enough to involve the optic thalamus, and likewise in Horrax's series, the majority of his cases extended deep into the thalamic region. These two series, therefore, agree in location regarding the optic thalamus and thus probably indicate that lesions of the occipital or temporal lobes may produce visual hallucinations, if they involve the primary tracts for vision, or the primary optic centers.

Foster Kennedy described the most unique case on record, that of a lady in blue seated in the hemianopic field, and the description of this "formed" image was probably the most elaborate of any so far described. Usually, the hallucinations are of a vague, indefinite type, the patient stating that they resemble a "dog," "goat," "tree," "bird," etc. Even with the well formed hallucinations, they are never the clearcut type seen in acute psychoses, and the theory that they are release centers of higher cortical memory areas does not appear to be justified, in that visual hallucinations of this vague and indefinite type are common experiences of everyday life which are recognized as illusions. For instance, at night an object seen on the road ahead may be misinterpreted as a rabbit or a small animal if one were in the country, and other senses orient the possibility of this object. On close inspection one may find it to be only a rock. A similar object seen at night without full detail in a crowded city street will give no such impression. The first interpretation might be that it was a hat or an object related to time, place and surroundings. Therefore, these ill formed hallucinations found in organic lesions of the visual pathways lack the control of orientation, and misinterpretation is probably due to some irritation of the visual pathways, reaching consciousness and demanding some interpretation, which is associated in a vague way to some familiar object.

Stimulation received by the visual pathways, whether due to light or to irritation at any point in the course from the retina to the occipital lobe, will probably find an attempted interpretation by the brain, and the "hallucinations" which are evolved probably depend on other sensory components being intact, without regard to time, place or surroundings.

Dercum reported a case of visual hallucinations from a plastic exudate surrounding the chiasm. Spiller and Posey reported a case of visual hallucination following a hemorrhage into the retina. Optic, tabetic crises are associated with atrophy of the optic nerves and frequently visual hallucinations accompany this condition, even though the patient may be blind. The occurrence, therefore, of visual hallucinations

is not of distinct localizing value, although I believe, as Cushing has pointed out, that the crude hallucinations are more frequently found in involvement of the occipital lobe than elsewhere.

DR. CHARLES FRAZIER: One should not make dogmatic statements as to distinction of field defects in tumors of the temporal and occipital lobes unless one has had an opportunity of taking the fields from the beginning. Unfortunately, in the majority of cases months have elapsed since the onset of the lesion so that whether the tumor was of occipital or of temporal lobe origin there is usually an hemianopsic field at first observation. In the early stages, however, it is more than likely that more tumors of the temporal lobe would give quadrantanopsia defects. As a matter of fact, in the last analysis it all depends on whether the tumor of the occipital lobe invades the visual center in the calcarine fissure at the beginning. If it invades at some point peripheral along the optic radiations, there is a greater likelihood of quadrant defects.

DR. R. W. WAGGONER: I agree with Dr. Fay in his summary of the cases in Henschen's series. It is obvious that there were multiple lesions in a number of his cases. Henschen apparently considered that the hallucinations were always in the hemianopic field.

An interesting theory as to the origin of visual hallucinations is that suggested by Kennedy in reference to those which arise from a lesion in the temporosphenoidal region. This area is said to be a storehouse for infantile memories, which function in later life is relegated to other areas of the brain. Stimulation of this area recalls these early infantile memories to consciousness, and thus visual hallucinations are produced.

Book Reviews

KÖRPERBAU UND GEISTESKRANKHEIT. Eine anthropologisch-klinische Untersuchung zur Beleuchtung des psychiatrischen Konstitutionsproblems. By MAX SCHMIDT. Pp. 206. Berlin: Julius Springer, 1929.

The substance of this book is a detailed report of an investigation which the author undertook as the solution of a research problem suggested by the University of Copenhagen, for which he won a gold medal. The problem was: "a comparison, based on anthropologic investigation, of the body types of patients with manic-depressive and schizophrenic psychoses." The author examined anthropologically 433 patients, 215 men and 218 women; 167 had manic-depressive psychoses (80 men and 87 women); 200 had schizophrenia (100 men and 100 women); 65 showed "less typical or wholly atypical psychoses."

The patients were examined by both somatoscopic and somatometric methods, with a careful statistical evaluation of the observations. The results led, on the whole, to a definite confirmation of Kretschmer's views. Of the 200 schizophrenic patients, 78.5 belonged to the leptosome, muscular and dysplastic groups, while only 12.5 per cent were in the pyknic group. On the other hand, of the 167 manic-depressive patients, 70 per cent were pyknic as against 19 per cent who were muscular, leptosome and dysplastic. Only 2 per cent of the manic-depressive patients showed dysplastic signs which were shown by 17 per cent of the schizophrenic group. Like several previous authors, the writer doubts whether the muscular type can be delimited clearly enough to be considered a major type. He believes that, in the development of the muscular types, exogenic factors play a great part. In his opinion, the most valuable expression for the two types which he considers do exist would be terms used by the old physicians; namely, habitus corporis laxus and habitus corporis strictus. He feels that the examination of body types cannot be used yet as a diagnostic or prognostic criterion. Only the existence of dysplastic manifestations can be used in clinical diagnosis. As examples of the two major type groups, he cites two famous figures in Denmark's history: King Christian VII, leptosome, asthenic, schizophrenic, whose psychosis has been described by Viggo Christiansen; and the broadly-built, pyknic, cyclothymic poet Grundtvig, whose life has been studied by Hellweg.

The large number of manic-depressive patients which the author was able to collect in one year makes one a little doubtful of his diagnostic criteria, since most investigators of the constitution problem have been able to muster up only a much smaller number of clearcut cases of this type. The author, recognizing the importance of the age factor, has attempted to select patients so that there should be at least approximately the same age average in the two psychotic groups. Such an attempt, however, has the disadvantage that since the average age of manic-depressive patients in hospitals is higher than that of schizophrenic patients, a selection of clinically less typical psychoses is necessarily made.

While it is impossible to discuss the many details brought up in the book, the anthropometric measurements deserve special discussion, since the author lays especial stress on them. He has found as the most constant quality of the type of habitus the breadth of the face: the broad face of the pyknic type (euryprosopia) as against the narrow face of the leptosome type (leptoprosopia). In his anthropometric measurements the author has put too much stress on individual absolute measurements. Differences in these absolute measurements between two groups of individuals can have only restricted significance. Too many investigations have been undertaken which deal only with single measurements or with indexes concerning small parts of the body, such as the ears. Deductions based on such data apparently advance the knowledge of constitutional types very little. What is needed is an anthropometric comprehension of the

whole body, expressed in indexes, such as the trunk-volume-limb length index or the anthropometric profiles of Andrew, to which Kretschmer has also drawn attention in the eighth edition of his book, "Physique and Character." Perkins, also, in a recent valuable paper, has indicated the importance of the anthropometric expression of the most important features of the whole skeletal configuration. Among the individual measurements used in the book under discussion, the author has included some which can have no significance at all, such as measurements taken from the navel, a point which is one of the least constant of the whole body.

In a special clinical chapter are discussed psychoses deviating in body type from the correlations found by Kretschmer. This material does not confirm the views of Mauz that a psychosis showing an "atypical" body type follows an atypical course. The author believes, however, that the existence of a pyknic habitus in a schizophrenic patient may be regarded as an indication of a heterologic constitutional disposition.

A comprehensive bibliography of the constitution problem in psychiatry is appended, for the more detailed discussion of which readers are referred by the author to the books by Wertheimer and Hesketh, Weidenreich and Georgi. The book has a number of excellent and instructive illustrations. Although, as a whole, it does not adduce any outstanding new facts, it is a welcome addition to constitutional literature, especially since it is based on extensive material.

DIE PSYCHISCHEN REAKTIONSFORMEN. Abhandlung aus des Neurologie, Psychiatrie, Psychologie und ihren Grenzgebieten. By HARRY MARCUSE. Number 50. Price, 22 marks. Pp. 262. Berlin: S. Karger, 1929.

This book offers a comprehensive account of the author's point of view, which he has expounded in a previous book and in a number of papers since 1913. The chief interest lies in many interesting details and observations, as well as in formulations, which show that the author, who is chief physician of the psychiatric institute at Herzberge in Berlin, has at his disposal a vast store of sound psychiatric experience. The system he expounds, however, is very formal.

Marcuse states that the content, or as he calls it the quality, of psychic reactions is of little importance. The source of psychologic and psychiatric knowledge is to be found in the intensity of psychic reactions. This intensity can be comprehended by introspection and by empathy of others. The term "reaction form" is used by him in the verbal sense, as meaning the form of psychic reactions alone, and not the content. He postulates, in accordance with Jodl, a "psychic force" which is the specific energy of the central nervous system. This psychic force operates in all mental reactions. Marcuse distinguishes different levels of psychic life, a view in which he closely follows the psychology of Jodl. The primary mental reactions are sensation, feeling and striving. None of these can ever exist in isolation; they are present in every mental reaction, but the psychic force can give more emphasis to one, so that the others can "become microscopic" (Jodl). Above this level there exist the secondary mental reactions, or representations. Representations, or representative reactions, are not something entirely different from the primary reactions, nor are they composed of these primary reactions, but they constitute a reproduction of them on a higher level, a reproduced striving, feeling or sensation. The primary elements, in other words, are reactions to a "presentative" stimulus, the secondary elements are reactions to a past or reproduced stimulus. The author duly gives credit to Jodl for having inaugurated a bidimensional view of psychic life. The secondary reactions represent a higher developmental stage than the primary ones. Marcuse arrives at the definition of "reaction forms" as the "dynamic proportion of the psychic forces of different developmental levels present in a psychic reaction, or their psychodynamic proportion." The intensity of the whole psychic reaction may be decreased or increased, and the relative proportion of psychic intensity of the primary reaction to the secondary reaction may be changed.

Applying these fundamental notions to psychopathology, the author arrives at the "energy theory of psychoses" which he first expounded in a book with that title in 1913. Abnormal mental reactions, he says, are characterized according to whether the psychic force is increased (or decreased) as a whole, and in the primary and secondary levels respectively. The different human constitutions, of which the author distinguishes six, are also defined by their difference in intensity of psychic force, and form the basis of the psychopathologic reactions. Two great "forms" of psychopathologic reactions are distinguished, the "somatogenic" and the "psychogenic," or the "catatonic" and the "hysterical." All the various forms of psychopathologic behavior are translated by the author into terms of variations of intensity in the primary and secondary levels. Although this is done not without ingenuity, it is not convincing. Throughout, he operates with formulas, in which *I* means intensity, *P*, primary reactions and *S*, secondary reactions. In his psychiatric approach he is drawn more to Ziehen and Hitzig, whom he quotes approvingly, than to Freud or Kretschmer, whom he rejects. Practically all phenomena which come from the primary sphere are "catatonic"; all those which derive from the secondary sphere are "hysterical." To the "catatonic" or "somatogenic" reactions belong schizophrenia, manic-depressive psychoses and paranoia. The last four chapters of the book deal with the application of the "energy theory" to psychotherapy, suggestion and hypnosis, simulation, amnesia, dreams and cultural achievements.

A number of case histories are given, especially of patients concerning whom the author has given expert opinions. These records are evidently based on sound facts. But while they help a good deal to illustrate the author's views, they do not come anywhere near proving them.

It is exceedingly difficult to do justice to a book in which oversystematized theory is strangely blended with clinical facts. While this "energy theory" of psychoses and its clinical amplifications have to be rejected for more than one reason, the book is, nevertheless, worth reading for the many interesting sidelights thrown on psychology and psychiatry, which do not lend themselves to summary.

LES OBSÉDÉS. By RAYMOND MALLET. Préface by J. Séglas. Collection des actualités de médicine pratique. Price, 12 francs. Pp. 100. Paris: Gaston Doin, 1928.

The book by Dr. Mallet forms part of a series which is designed to give concise information about various medical subjects of current interest. Obsessions, as Séglas points out in his brief preface, constitute a chapter of psychiatry to which in the past French writers have made most important contributions. The author of this book, a pupil of the distinguished psychiatrists Gilbert Ballet and Chaslin, presents his subject with great facility and not without a certain literary charm. He begins by giving a number of case abstracts. In them the verbal statements of some of the patients are instructive and afford good examples of obsessive conditions. From the author's selection of illustrative cases, however, one can already discern that he is inclined to emphasize the physical aspects of obsessive neuroses. In fact, he states that all obsessive conditions show "the same organopsychic substratum" (p. 24).

Symptomatologically, he regards anguish as the basis of all obsessive manifestations: "Tout obsédé est angoissé" (p. 27). He distinguishes three series of symptoms: physical discomfort, such as sensations of pharyngeal or epigastric constriction; emotional uneasiness, such as feelings of insecurity or fear, and an intellectual disorder, "an incoercible excitation at times diffuse or caught up in a mental content more or less isolated, that is, obsessing" (p. 27). He gives the following description of an obsessive idea: "An idea which invades the field of consciousness with such spontaneity, with no connection whatsoever with the usual preoccupations of the subject — even in flagrant contradiction to them — which takes on such magnitude, sweeping everything around it, which attains such intensity, taking on almost a sensory character, that the patient experiences a sort of intellectual vertigo, just as others may experience a physical vertigo. And as the latter

gives the impression of imminent death, the former gives that of imminent loss of all reason" (p. 33).

The author considers the physical symptoms of especial importance in the clinical picture. He speaks here mainly of physical sensations, which he describes as "incomplete, parasitic, irreducible." His conception is that "the obsessive element is furnished by a sensation which has the same peculiarities as the (obsessive) idea which it can replace" (p. 38). He considers the "obsessed" person as an "organic patient." In the chapter on clinical forms, the author remains on rather formal ground. He discusses the relationship between obsessive states and schizoid reactions, drawing chiefly on Minkowski's presentation of Bleuler's views. In the chapter entitled, "Pathogenic Considerations," he rules out any dynamic psychologic understanding of obsessive conditions and states clearly his view that "the mental content (l'élément représentatif) plays only an accessory rôle in obsessions" (p. 17). He points out, instead, physical factors — mainly in the sphere of the vegetative nervous system — heredity and infections, without giving any clear evidence, however, for the existence of clinical facts. The chapter on treatment gives but scant advice. The physician, he states, should "collaborate with the patient in the work of synthesis"; he should "reassure the patient that his fears are unfounded," and he should "promise him relief." "This," the author concludes, "is psychotherapy" (p. 91). Physical therapy, and especially sedative medication (opium, bromide), is advised. The author considers antisyphilitic treatment indicated in obsessional states, even when the laboratory observations are negative, in view of the possibility of congenital syphilis. He is against psychoanalysis, and concludes that "in considering the person with obsessions as an organic patient, and not as one possessed by the demon of sexuality, one is at least encouraged by the progress of our knowledge...." (p. 44).

The psychopathologist may glean some interesting details and descriptions from this book. In the hands of the general medical reader, to whom it is addressed, it will do more harm than good, since it discourages the physician from considering the psychologic side in obsessive states.

ARTHRITIS AND RHEUMATOID CONDITIONS. Their Nature and Treatment. By RALPH PEMBERTON, M.S., M.D. Price, $5.00. Pp. 337, with 43 illustrations. Philadelphia: Lea & Febiger, 1929.

The subject of arthritis is of the utmost interest to neuropsychiatrists, for the same mechanism that underlies arthritic symptoms in one patient may bring about in another disturbances of function in nervous structures. Indeed, the relation has been long recognized, for the problem of arthritis is the problem of medicine itself.

The author has attacked the problem from the laboratory standpoint, and not, as it has been approached hitherto, from its purely clinical aspects. The results on which this work is based have been, in large part, the work of the author and his associates. It is safe to say that the results of their laboratory work and treatment of arthritis create a new epoch in the outlook for this protean disease.

It would lead too far afield to give in detail the basis of the dynamic pathology of arthritis. Suffice it to say that a disturbance of circulation, probably in the nature of closed capillary areas, constitutes an important part of the pathologic side of arthritis and the rheumatoid syndrome. By means of experiments on normal, as contrasted with pathologic, persons, this is rather well proved. This fact, in itself, points the way to treatment.

The incidence of nervous symptoms in arthritis is well shown, for in a large percentage of cases tinnitus, paresthesia, twitchings of various sorts, vertigo, muscular cramps and persisting headache were common symptoms. Moreover, most of these symptoms disappeared as the patients improved. The general relationship of pains to arthritis, with which every neurologist is familiar, is emphasized.

Of no less interest is the part of the book which concerns itself with treatment, for in arthritis, as well as in psychoneuroses, the treatment is more or less the same, and therefore the removal of infections, the diet and particularly the physiotherapy are of interest both to the internist and to the neurologist.

In this respect, the chapters on physiotherapy, dealing particularly with the use of heat and massage, are of interest, for Pemberton has shown the physiologic basis on which the value of these measures rests.

Altogether, this is an exceptional book in that it presents the subject of arthritis from a scientific point of view, and at the same time gives methods of treatment which arouse hope that something can be accomplished for the great army of persons who suffer from this devastating disease.

MENTAL DEFICIENCY (AMENTIA). By A. F. TREDGOLD. Fifth edition. Price, $7.50. Pp. 535. New York: William Wood & Company, 1929.

The first edition of this book appeared in 1908. Reviews of two previous editions have appeared in the ARCHIVES. The present volume, which is much larger than its predecessors, has been largely revised, although the general plan of the book remains the same. Some chapters have been entirely rewritten. American readers will be interested in the fact that important alterations in the legal definitions have been made by the Act of 1927; they have been incorporated in the present volume. The author has also wisely incorporated the investigations of E. O. Lewis, who, on behalf of the Joint Mental Deficiency Committee of the Board of Education and Board of Control, has made a new investigation regarding the number and condition of defectives in England. As conditions in England are in no way different from those in this country, the subject will be of equal interest to American readers.

The fact that it has been found necessary to increase the size of the volume is an evidence of the growing interest in mental deficiency. This has been true not only in English speaking countries, which have taken the lead in such matters, but throughout the world. The book remains the best work on mental deficiency.

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